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CHEMICAL CORPS MEDICAL LABORATORIES

RESEARCH REPORT

Report No. 215

WOUND BALLISTICS TESTS OF .22 CALIBER BULLETS FOR THE M4 AIR FORCE SURVIVAL GUN

by

Arthur J. Dziemian

September 1953

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Medical Laboratories Research Report No. 215

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Wound Ballistics Tests of .22 Caliber Bullets
For the M4 Air Force Survival Gun

ABSTRACT

OBJECT.

The object of this investigation was to determine, by wound ballistics tests, the most efficient bullet of a series of .22 caliber full patch rounds.

RESULTS AND CONCLUSIONS.

1. The wounding efficiency as determined by tests on standard gelatin cylinders, of the 35 grain full patch 62020 .22 caliber survival gun bullet is superior to that of the 45 grain full patch 62021 bullet or of the 45 grain full patch round nose contract bullet at real ranges of 10, 75 and 100 yd.

2. The .22 caliber 35 grain full patch 62020 bullet causes more tissue damage in animals at real ranges of 10, 75, and 100 yd. than does either the 45 grain full patch 62021 bullet or the 45 grain full patch round nose projectile.

3. This superiority of the 35 grain 62020 bullet over the other two full patch bullets is due to its greater instability in the targets. This greater tumbling ability of the 62020 bullet causes the energy of the projectile to be transferred to the target within a shorter distance of bullet penetration than for either the 62021 or the round nose bullet.

4. The .22 caliber 35 grain full patch 62020 bullet at 100 yd. real range has 54% of the wounding efficiency of the .22 caliber soft point Hornet bullet at the same range. This figure is close to the approximately 3/5 value desired by the Office of the Chief of Ordnance.

RECOMMENDATIONS.

It is recommended that the .22 caliber 35 grain full patch 62020 bullet be used in the M4 Air Force Survival weapon.

Medical Laboratories Research Report No. 215

Wound Ballistics Tests of .22 Caliber Bullets
For the M4 Air Force Survival Gun

I. INTRODUCTION.

A. Object.

The object of this investigation was to determine, by wound ballistics tests, the most efficient bullet of a series of .22 caliber full patch rounds.

B. Authority.

These tests were authorized under Projects 6-99-02-001 and 4-99-02-001 and were supported by the Ordnance Corps, Air Force, Medical Service and Chemical Corps.

II. HISTORICAL.

The M4 Air Force survival weapon is a light two barreled gun to be used for hunting small game for food. The barrels are of the over and under type, one being for .410 gauge shotgun shells and the other being chambered for a Hornet type .22 caliber cartridge. The regular commercial Hornet projectile used for hunting is a soft nose expanding bullet, which transfers all, or most, of its impact kinetic energy to the target. However, the use of this type of bullet is contrary to the rules of land warfare. It was feared that personnel, captured by the enemy, with this type of ammunition in their possession would be considered violators of the Geneva Conventions.

A round nose full-patch .22 caliber bullet was made as a substitute for the soft point bullet. Preliminary wound ballistics tests, described in this paper, were made to compare the wounding powers of the two projectiles. These tests showed that the full patch bullet was markedly inferior to the soft point projectile.

It was felt that the wounding power of full patch .22 caliber bullets could be increased and the Office of the Chief of Ordnance (OCO) (1) set up the following characteristics to be considered for such a bullet:

a. The cartridge to have a full jacketed bullet, the visual examination of which would not appear to be in conflict with the Hague Convention limitations.

b. Meet accuracy specifications at least equal to commercial ammunition in the M4 weapon.

c. Provide wounding efficiency of approximately 3/5 that of the 45 grain soft point bullet at 100 yd. range. Transient cavitation in established

type gelatin blocks is the accepted means for determination of quantitative wounding efficiency. In this regard, it is recommended that test methods and procedures of the contractor and the Wound Ballistics Laboratory, Army Chemical Center, be correlated.

d. Final cartridge to feed satisfactorily through the M4 survival rifle.

e. Performance to be established on the basis of 100 yd. range.

f. Pressure limits to be same as specified by SAAMI.

Conferences were held with members of OCO and representatives of the laboratories of the Winchester Repeating Arms Co., Olin Industries, Inc. and it was decided to design experimental bullets with a view to increasing their tumbling abilities in tissues and tissue models. The Winchester Company made several types, under Contract DA-19-059-ORD-1283. These were tested at this laboratory and the results are given in this paper.

III. EXPERIMENTAL.

A. Materials.

1. Gelatin - Pharmagel A, Kind and Knox
2. .22 Caliber 14 in. long gun barrels
3. Fixed gun mount with Universal receiver
4. Bench rest gun mount
5. V-shaped fixed gun mount
6. .22 caliber Hornet type bullets:
   a. 45 grain soft point
   b. 45 grain full patch round nose
   c. 45 grain full patch 62021
   d. 35 grain full patch 62020
7. Micronex x-ray apparatus, cassettes and films
8. Standard x-ray appratus
9. Fastax high speed 8 mm. motion picture camera and film

10. Chronographs, Potter

11. Preset interval timer, Potter

B. Animals.

1. Normal goats

2. Normal rabbits

C. Procedure.

Four types of .22 caliber rounds for the M4 survival gun were tested. In all, the slugs were of lead with a maximum antimony content of 2.5% and the jackets were of gilding metal. One projectile type was the standard commercial 45 grain Hornet bullet with an unjacketed nose and the others were full-jacketed (full patch) bullets of different shapes and sizes.

The bullets used were as follows:

1. .22 caliber Hornet 45 grain soft point (Fig. 1A,2)

2. .22 caliber Hornet 45 grain full patch round nose (Fig. 1B,3)

3. .22 caliber Hornet 45 grain full patch 62021 (Fig. 1D,4)

4. .22 caliber 35 grain full patch 62020 (Fig. 1C,5)

The drawings in Fig. 2 to 5 were supplied by the Winchester Repeating Arms Co., New Haven, Conn.

The barrels used were 14 in. long and had a rifling of 1 twist in 16 in. Three different mounts were used: a fixed mount with a universal receiver, a fixed v-shaped mount (Fig. 6) and a bench rest mount (Fig. 7). For the latter, the barrel was placed in a tube larger than the barrel, and the interspace was filled with solder to give weight to the gun. This was fixed with a stock and telescopic sight and was fired from a bench.

Bench rest firing was done at the 75 and 100 yd. ranges before the v-shaped mount was available, after which the v-shaped mount was used. Accuracy with the latter mount was superior to that with bench rest firing.

The bullets were fired in the following manner:

10 yd. range - all shots - from a fixed mount, using a universal receiver.

75 yd. range - shots at 12 cm. gelatin cylinders - from a bench rest.

100 yd. range - shots at 12 cm. gelatin cylinders and rabbits - from a bench rest.

100 yd. range - shots at 38 cm. gelatin blocks and goats - from a fixed v-shaped mount.

An estimate of the accuracies of the four types of bullets was made by firing 10 rounds each at 100 yd. range from the fixed v-shaped mount at panels of white cardboard.

Microsecond roentgenograms at known intervals after bullet impact were made of the temporary cavities formed by the bullets in standard 20% gelatin cylinders (12 cm. long and 12.4 cm. in diameter) at real ranges of 10, 75, and 100 yd. The volumes of the cavities were determined as described previously (2) and corrected for x-ray magnification and gelatin temperature (unpublished data). The standard temperature used was 10°C.

High speed (15,000 - 16,000 frames/sec.) 8 mm. motion pictures were taken with a Fastax Camera of the bullets penetrating or perforating rectangular blocks of 20% gelatin approximately 15x6x5 in. (38x15.2x12.7 cm.) at real ranges of 10 and 100 yd. These films were inspected frame by frame to determine the distances the bullets penetrated before they began to tumble and also to determine the total penetration distances of the bullets.

Rabbits, anesthetized with sodium pentobarbital intravenously, were shot through various parts of the anatomy at real ranges of 10 and 100 yd., in an attempt to compare the wounding power of the four types of bullets on small animals. Photographs were made of the wounds and standard x-rays were taken to study bone destruction.

Unanesthetized goats were shot at 10 and 100 yd. real ranges through the thorax from the front to strike the heart. These animals were autopsied and the amount of tissue destruction in the heart was recorded.

D. Results.

1. Velocity and Energy.

In Table 1 are listed the striking velocities and the striking energies of the four bullets tested at 10, 75 and 100 yd. ranges. In column 3 the recorded muzzle velocities were measured with silver screens and counter chronographs. The striking velocities at 10, 75 and 100 yd. ranges were from data supplied by the Winchester Repeating Arms Co. (3). The striking energies were calculated form the relation:

$$E = MV^2/2g$$

Where: E = kinetic energy in ft. lbs.

M = mass in lb.

V = velocity in ft./sec.

g = 32.2, acceleration due to gravity in ft./sec.

TABLE 1

Striking Velocities and Energies of .22 caliber Hornet Type Bullets

Bullet	Range Yd.	Muzzle Velocity ft./sec.	Striking Velocity ft./sec.	Striking Kinetic Energy ft. lbs.
45 grain soft nose	10	2460	2426	587
	75		2046	418
	100		1934	373
35 grain full patch 62020	10	2777	2735	581
	75		2353	430
	100		2207	378
45 grain full patch 62021	10	2469	2442	595
	75		2136	455
	100		2024	409
45 grain full patch round nose	10	2513	2476	612
	75		2030	411
	100		1904	362

2. Accuracies at 100 yd. real range.

Shot patterns made at 100 yd. range from a barrel fired in the v-shaped fixed mount indicated that the 35 grain 62020 bullet was more accurate than the 45 grain 62021 projectile (Fig. 10 and 11). This was also the conclusion reached after firing at both animal and gelatin targets. There were fewer misses or bad shots with the 62020 bullet than with the 62021. The most accurate bullet of the four tested was the 45 grain round nose contract bullet, as was shown by the dispersion pattern (Fig. 9) and the animal and gelatin shots. The 45 grain soft nose Hornet bullet and the 35 grain 62020 bullet appeared to be about equal in accuracy at the 100 yd. range (Fig. 8 and 11).

3. Temporary cavity volumes.

10 yd. range - the histories of the temporary cavity volumes during the 6000 microsecond period after bullet impact are shown in Fig. 12 to 15 for the 35 grain full patch 62020 bullet, the 45 grain full patch 62021 bullet, the 45 grain round nose contract bullet and the 45 grain soft nose Hornet bullet. A composite of the curves is shown in Fig. 16. Dispersions were much less with the soft nose Hornet and the round nose contract bullets than with the remaining two full patch balls. The soft nose Hornets began to expand very shortly after they hit the gelatin and the 45 grain round nose bullets did little or no tumbling during passage through the cylinder. However, the 62020 and 62021 bullets

varied in the distance to which they penetrated the target before beginning to tumble, thus transmitting varying amounts of energy to the gelatin and producing varying temporary cavity volumes.

The 35 grain 62020 bullet was superior in its cavity producing power to the 45 grain 62021 bullet, there being almost no overlap in the dispersion of the points shown in Fig. 13 and 14. The 45 grain round nose bullet was considerably inferior in wounding power to either of the other two full patch bullets.

In Fig. 17 are examples of roentgenograms of maximum temporary cavities produced by the four types of bullets in standard gelatin cylinders at 10 yd. range.

75 and 100 yd. ranges - At both of these ranges, the 35 grain 62020 bullet was superior in wounding power to the 45 grain 62021 bullet, but the differences were not as marked as they were at 10 yd. range (Fig. 18-25). The curves for the 45 grain round nose contract bullet at 75 and 100 yd. range shown in the composite graphs (Fig. 21 and 25) were estimated from data obtained previously for other non-tumbling .22 caliber bullets (4).

Examples of roentgenograms of maximum temporary cavities produced by the soft nose, 62020 and 62021 bullets in standard gelatin cylinders at 75 and 100 yd. real range are shown in Fig. 26 and 27.

The results showing the maximum temporary cavity volumes produced by the four types of bullets at ranges of 10, 75, and 100 yd. are summarized in Table 2.

4. Tumbling of the bullets.

By taking high speed motion pictures of the bullets penetrating 38 cm. long blocks of 20% gelatin the instability of the bullets in this medium could be studied. The point of the intial tumbling of a bullet was determined by examining the film frame by frame and measuring the distance to which the bullet penetrated the gelatin before tumbling.

Fig. 28 shows the distances to the beginning of tumbling of the three full patch bullets tested at 10 and 100 yd. ranges. The soft nose bullets began to expand shortly after they struck the gelatin.

The 35 grain 62020 bullet was on the average the most unstable bullet in gelatin of the three full patch bullets tested. The 45 grain round nose bullet was very stable in gelatin at 10 yd. range. This stability is reflected in the relatively small cavity produced in the standard 12 cm. long gelatin cylinders by this bullet, as compared with the large cavities caused by the two sharp nosed full patch balls (Fig. 16).

TABLE 2

Maximum Temporary Cavity Volumes Produced by .22 Caliber Hornet Type Bullets in Standard 20 % Gelatin Cylinders

Bullet	Mean Muzzle Velocity ft./sec.	Coefficient of Variation of Mean Velocity %	Vol. at 10 yd. Range cc.	% of Soft Nose Cavity Vol.	Vol. at 75 yd. Range cc.	% Soft Nose Cavity Vol. cc.	Vol. at 100 yd. Range cc.	% soft Nose Cavity Vol. cc.
45 Grain soft nose	2460	± 1.36	1070	----	620	----	475	----
35 Grain full patch 62020	2777	± 0.77	700	65	330	53	255	54
45 Grain full patch 62021	2469	± 0.72	430	40	310	50	181	38
45 Grain full patch round nose	2513	± 1.22	235	22	86*	14*	74*	16*

* - calculated from other data - MLRR No. 94 , December 1951.

The amount of energy transferred from the .22 caliber round nose contract bullet to the 38 cm. long gelatin blocks at 10 yd. range during the bullet's passage was measured by determining the striking and residual velocities of the bullet (Table 3). The percentage of striking kinetic energies absorbed varied considerable, from 51.4% to 92.9%, averaging 78.8%. The variation was caused by the different distances at which the bullet tumbled (Fig. 28) and also by varying lengths of travel through the block. The bullets were deflected on tumbling, to some extent, from a straight path through the gelatin. The more curved the path, the greater was the amount of energy transferred to the block. At 10 yd. range, all the other types of bullets tested failed to perforate the 38 cm. of gelatin. In all these cases 100% of the bullet's striking energy was abosrbed by the target.

TABLE 3

Energies Absorbed by 38 cm. Long 20% Gelatin Blocks from .22 Caliber Full Jacket Round Nose Contract Bullets at 10 yd. Range

	Striking Velocity ft./sec.	Striking Kinetic Energy ft. lbs.	Energy Absorbed ft. lbs.	% of Striking Energy Absorbed
	2467	607.4	531.7	87.5
	2452	600.0	432.9	72.2
	2437	592.7	550.4	92.9
	2570	659.2	491.0	74.5
	2437	592.7	548.8	92.6
	2439	593.7	305.3	51.4
	2491	619.3	497.4	80.3
Av.	2470	609.3	479.6	78.8

At 100 yd. range the 35 grain 62020 bullet was again more unstable in gelatin than the other two full patch bullets, with the round nose bullet being the most stable. At 100 yd. range both the 62020 and 62021 bullets penetrated farther into the gelatin before tumbling than at 10 yd. The round nose bullet, on the average, tumbled in less distance at 100 yd. than at 10 yd.

The greater instability of the two pointed nose bullets at 10 yd. than at 100 yd. was reflected in the greater total penetration of the gelatin by the bullets at 100 yd. than at 10 yd. (Fig. 29). The round nose contract bullets perforated the 38 cm. gelatin blocks at both 10 and 100 yd. ranges. The soft nose Hornet bullet penetrated slightly less gelatin at 100 yd. than at 10 yd. range.

Fig. 30 to 37 show the progress of the bullets through the 38 cm. blocks of 20% gelatin at both 10 and 100 yd. ranges as demonstrated by the high speed motion picture films. The time interval between each separate picture is 125 microseconds.

5. Rabbit Shots.

The amount of tissue destruction produced by the four types of .22 caliber bullets in small animals was studied by firing these bullets at anesthetized rabbits at real ranges of 10 and 100 yd. The rabbits averaged 1.94 kg. in weight. Three animals were shot with each type of bullet at each range. The shots were aimed at the abdominal, thoracic and pelvic regions. After being hit, the wounds were examined and photographed. X-rays were taken of animals in which bone was struck.

In general, the results were as follows: At both 10 and 100 yd. ranges the greatest amount of tissue destruction was produced by the 45 grain soft nose Hornet bullet. Next in destructive capabilities at both ranges was the 35 grain full patch 62020 bullet. The 45 grain 62020 and round nose projectiles were about roughly equivalent in their action on the rabbits' tissues.

Fig. 38 and 39 show the exit wounds produced by the four bullets when fired at 10 and 100 yd. range at the abdominal regions of rabbits. The larger wounds produced by the soft nose and 62020 bullets can be seen in these pictures.

Fig. 40 shows roentgenograms of the pelvic regions of three rabbits hit at corresponding points on the body with the soft nose bullet, the 62020 bullet and the 62021 bullet at 10 yd. range. The amount of bone destruction was greatest with the soft nose bullet and least with the 45 grain 62021 projectile. The bullet fragments which can be seen distributed through the tissues in Fig. 40A are typical of all shots made with the soft nose Hornet bullet. The exit wounds corresponding with the x-rays are shown in Fig. 41.

6. Goat Shots.

These shots were made to determine the amount of tissue destruction in the heart when struck by an experimental bullet. Each shot was aimed at the thorax of the goat, from the front, so as to hit the heart. The animals were unanesthetized and were held relatively quiet in a frame in which the horns and hooves were clamped. Eight goats in all were shot, one with each type of bullet at 10 yd. and one with each at 100 yd. real range. All animals shot were incapacitated almost immediately, and died on the average, 4.5 min. after being struck. X-rays were made of the animals which showed no exit wounds, to show the location of the bullet and autopsies were performed immediately after the deaths of the animals. Photographs of the exit wounds of the hearts are shown in Fig. 42 and 43. Measurements of the sizes of the entrance and exit wounds of the hearts are listed in Table 4.

TABLE 4

Results of Heart Shots in Goats

Goat No.	Body Weight kg.	Bullet	Range Yd.	Size of wound - cm. Entrance	Exit	Survival Time Minutes
778	28.6	45 grain soft nose	10	5.1 x 5.1	1.5 x 3.7	3
777	35.9	35 grain full patch 62020	10	0.5 x 0.8	5.0 x 3.4	4
779	32.2	45 grain full patch 62021	10	Chambers opened		3
780	38.6	45 grain full patch round nose	10	0.6 x 0.4	1.0 x 2.2	3
774	38.6	45 grain soft nose	100	Tangential wound	4.5 x 0.9	7
773	27.7	35 grain full patch 62020	100	-----	5.4 x 4.7	4
775	25.9	45 grain full patch 62021	100	0.6 x 0.3	2.7 x 0.7	4
776	40.0	45 grain full patch round nose	100	0.4 x 0.4	1.3 x 1.3	4

The 45 grain round nose bullet caused the least destruction of heart tissue (Fig. 42C,D). Because of its stability in the tissue the bullet did little or no tumbling while passing through the heart.

The fact that the entrance wound in the heart caused by the soft nose bullet fired at 10 yd. into goat 778 was larger than the exit wound was probably because the bullet mushroomed just before it reached the heart, thus dissipating most of its energy anterior to the organ. The same type of bullet fired at 100 yd. hit on one side of the heart, causing a tangential gutter type wound (Fig. 42B).

The 35 grain 62020 bullet produced large wounds in the heart at both 10 and 100 yd. range (Fig. 43A,B). At the 100 yd. range the cavitation caused by the tumbling bullet blew out the ventricle so that one large wound was formed (Fig. 43B).

The most severely damaged heart was the one hit by the 45 grain 62021 bullet at 10 yd. range (Fig. 43C). Here, both of the ventricles were blown open by the cavitation caused by the tumbling bullet. However, tissue destruction produced by this bullet at 100 yd. range was less than that caused by the 35 grain 62020 projectile (Fig. 43B,D).

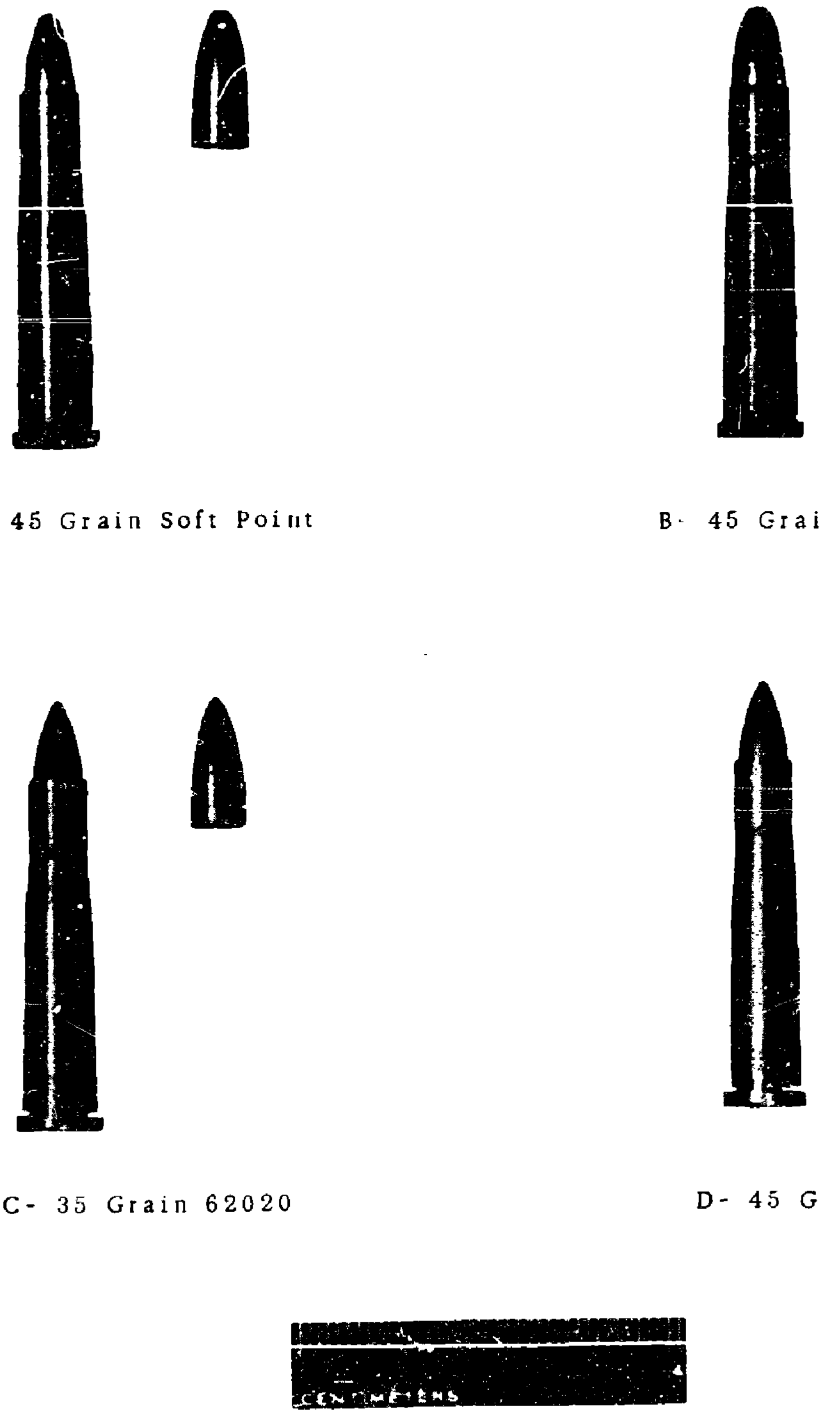
The entrance wounds in the chests of the animals were similar for all bullets, being circular holes with about the same diameters as the projectiles.

Deformation of the Bullets. The .22 caliber soft nose bullets all expanded and broke up in 20% gelatin and in animal tissues at all ranges tested. X-rays (Fig. 40A) and autopsies showed that bullet fragments were scattered through the tissues at the site of the wound.

The 35 grain 62020 bullets were flattened by their passage through 20% gelatin at both 10 and 100 yd. range. In Fig. 44 are shown such bullets recovered from 38 cm. long gelatin tissue models. This flattening increases the surface area of the projectile presented to the target, so that a greater part of the striking kinetic energy can be transferred to the target in a shorter distance than if the bullet remains undeformed. These results are similar to those seen with the .30 caliber M2 rifle ball (5). That a similar phenomenon occurs in animal tissue is shown by the bullet recovered from goat no. 777 shot at 10 yd. range. (Fig. 44C).

The 45 grain 62021 bullet also was deformed in both gelatin (Fig. 44D) and animal tissues (Fig. 44F) at 10 yd. range. The latter bullet was recovered from goat no. 779. At 100 yd. range there was but little deformation of the 62021 bullet in 20% gelatin (Fig. 44E).

The 45 grain full patch round full patch round nose bullet also showed deformation after perforating 38 cm. of 20% gelatin at 10 yd. range, but not as much as either the 62020 or 62021 bullets (Fig. 44G).



A - 45 Grain Soft Point

B - 45 Grain Round Nose

C - 35 Grain 62020

D - 45 Grain 62021

Fig. 1- .22 Cal. Bullets and Cartridges

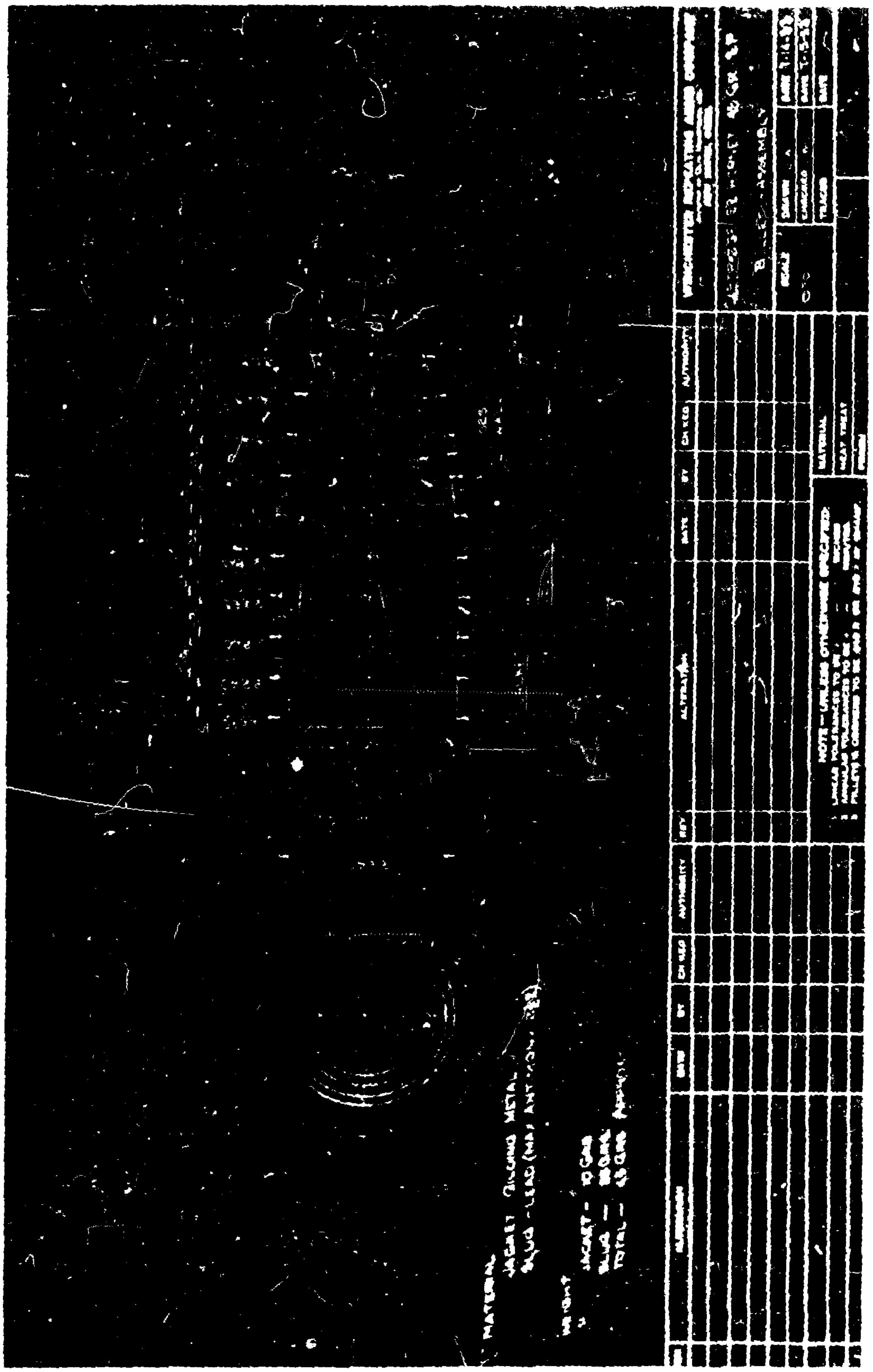


Fig. 2 - 45 Grain .22 Cal. Soft Point Hornet Bullet

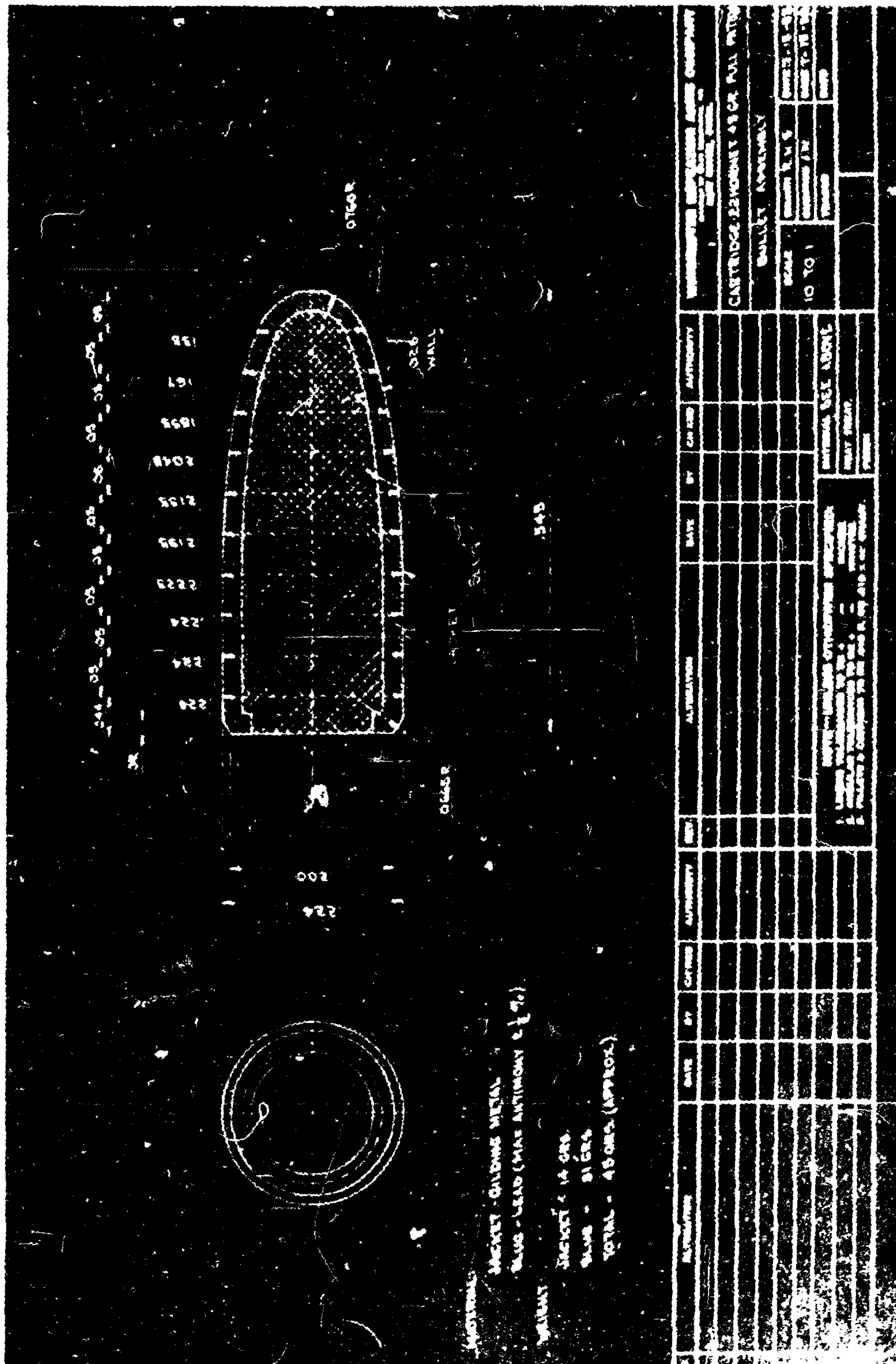


Fig. 4 - 45 Grain .22 Cal. Full Patch Round Nose Bullet

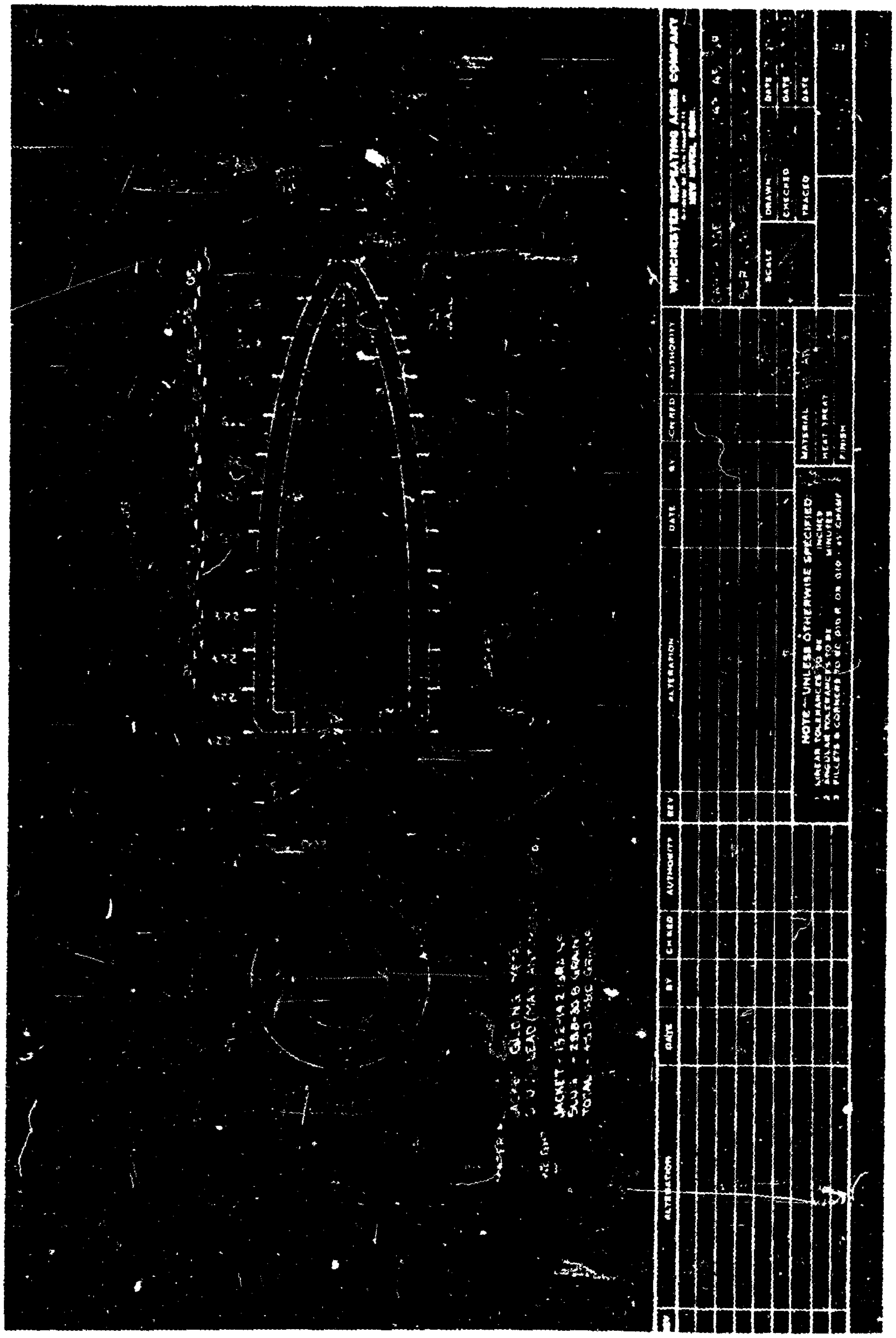


Fig. 4. 45 Grain .22 Cal. Full Patch 62021 Bullet

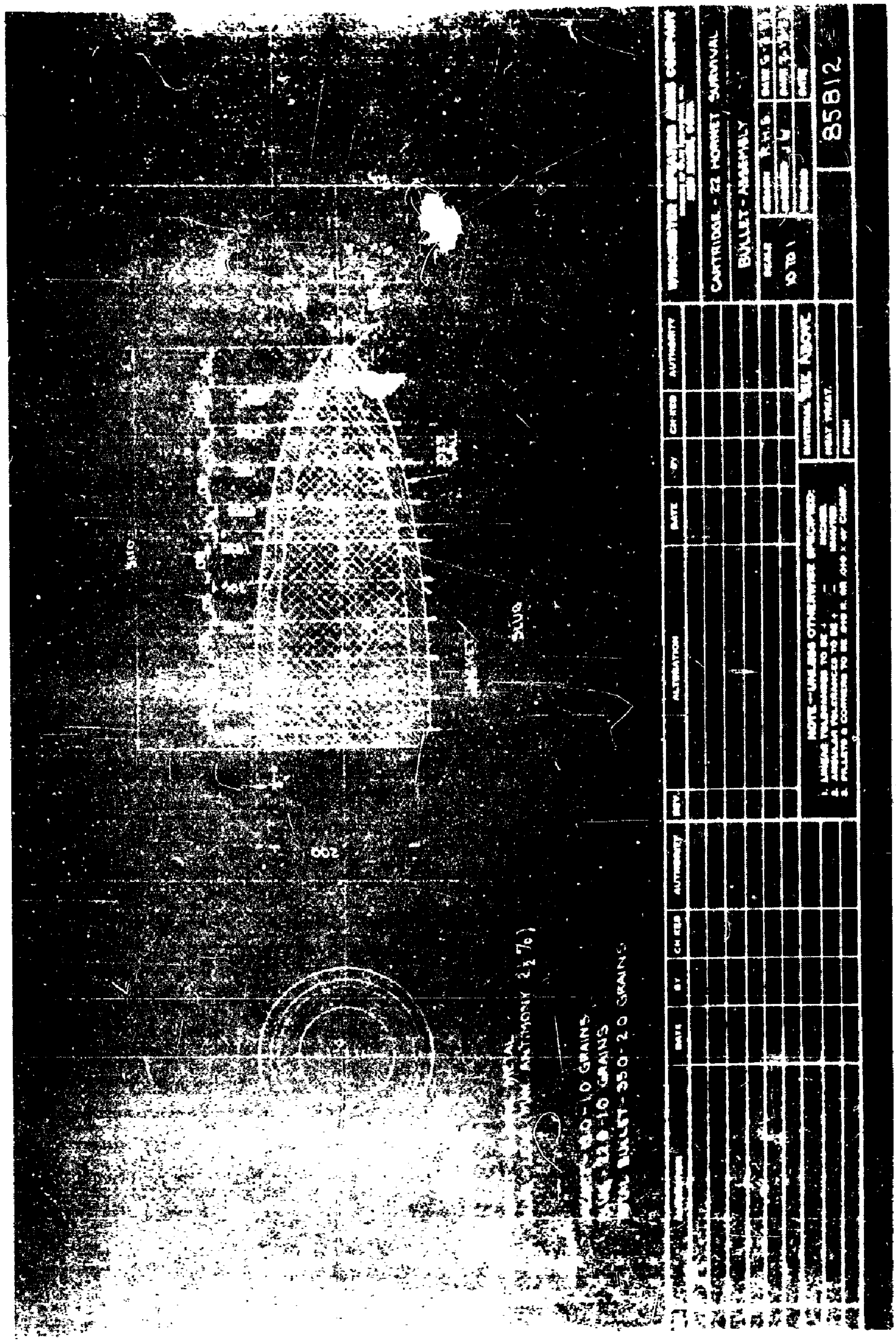


Fig. 5- 35 Grain .22 Cal. Full Patch 62020 Bullet

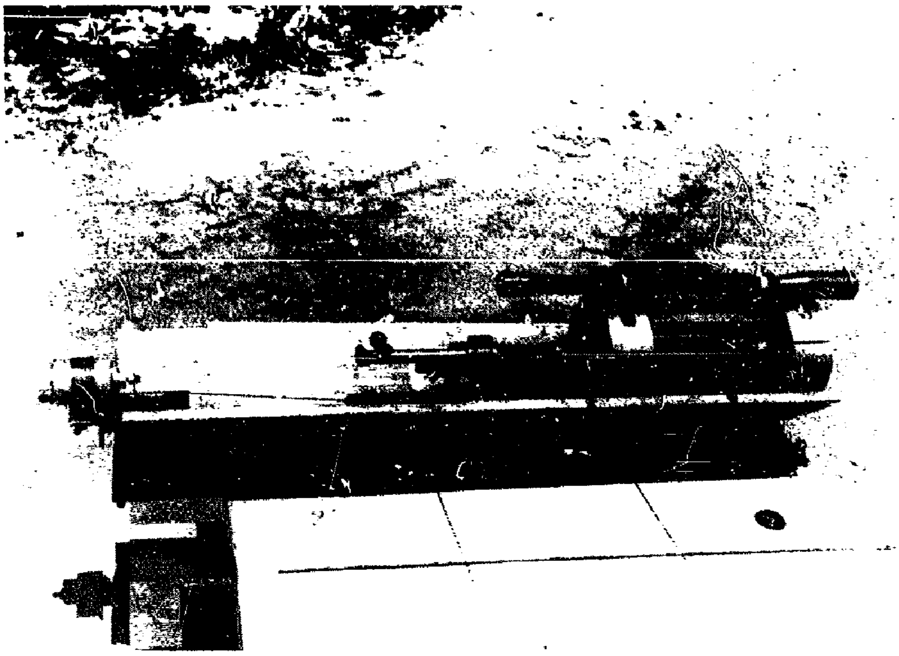


Fig. 6- V-Shaped Fixed Mount

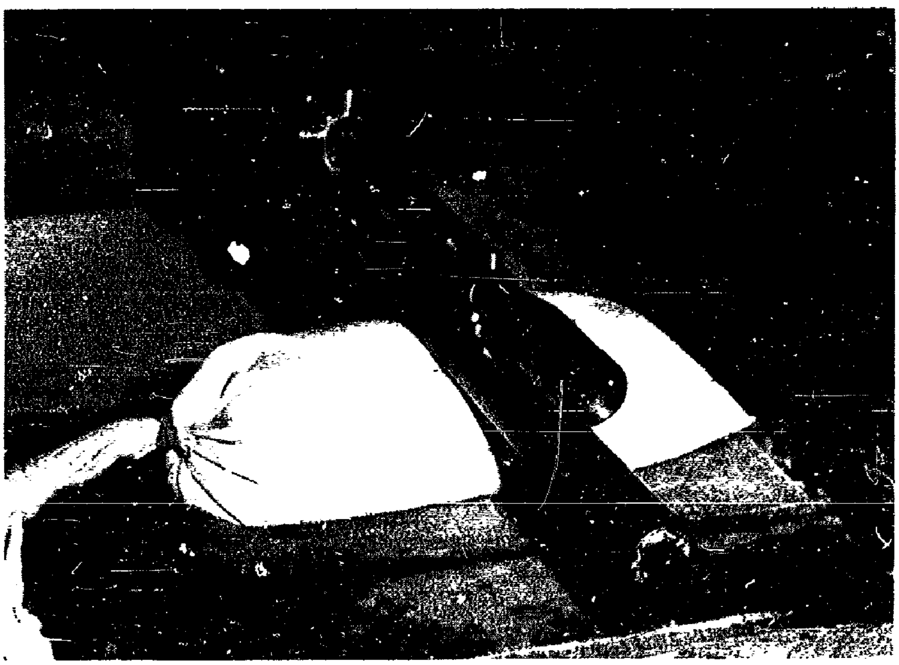


Fig. 7- Gun for Bench Rest Firing

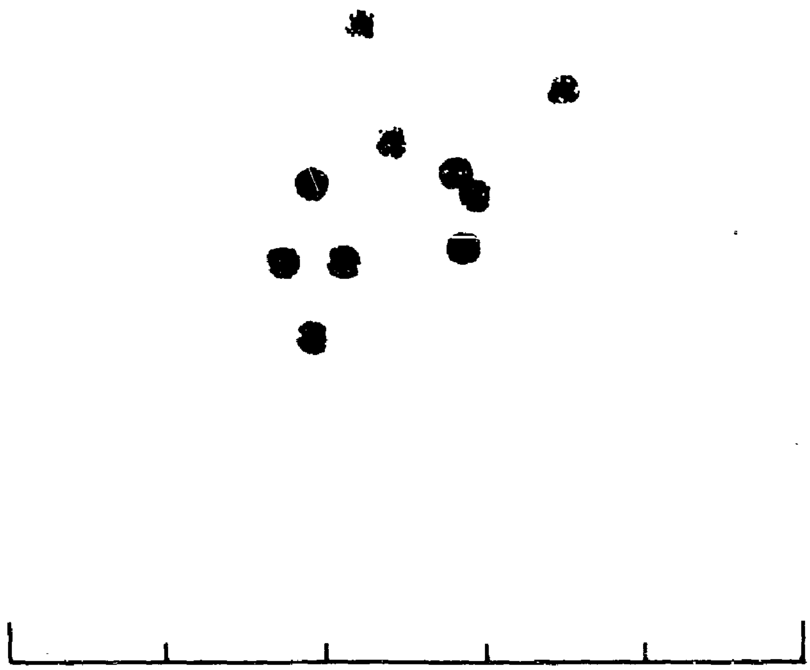


FIG. 8 -.22 CAL. 45 GRAIN SOFT POINT
HORNET BULLET

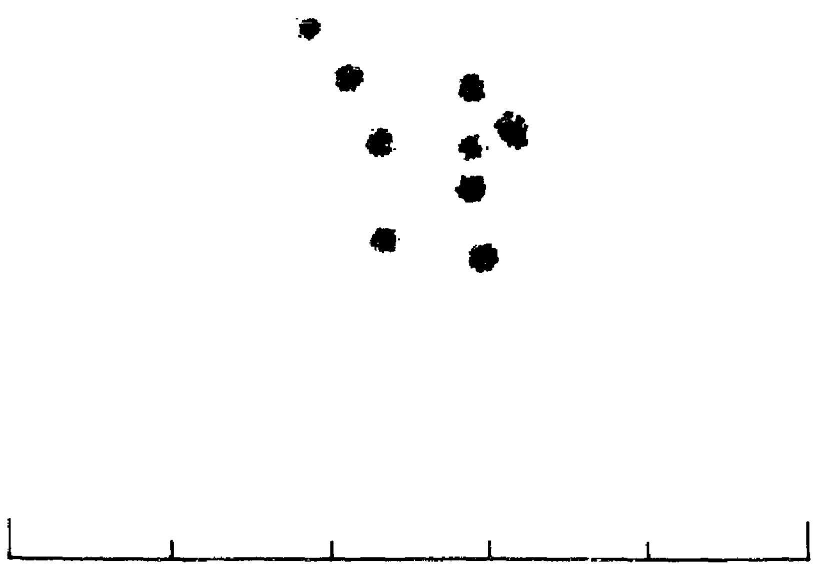


FIG. 9 -.22 CAL. 45 GRAIN FULL PATCH
ROUND NOSE CONTRACT BULLET

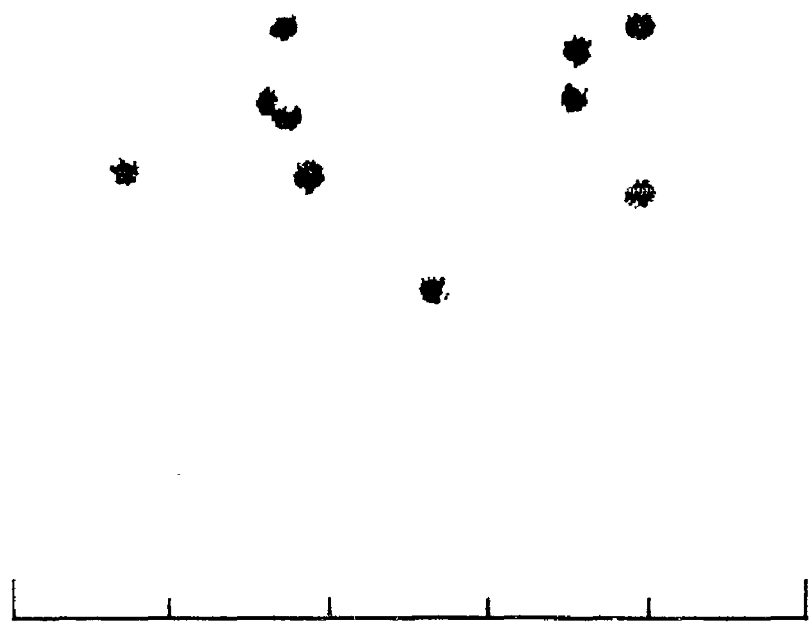


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FIG. 10 -.22 CAL. 45 GRAIN FULL PATCH
62021 BULLET

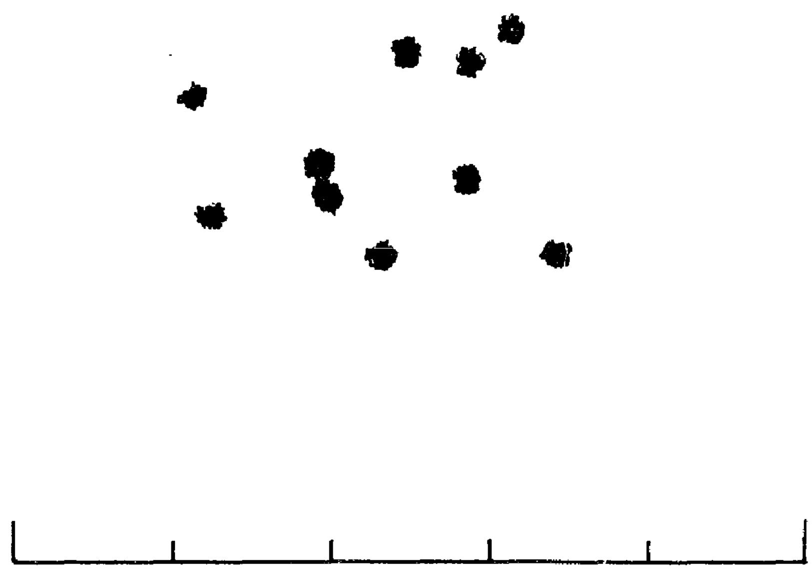

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FIG. 11 -.22 CAL. 35 GRAIN FULL PATCH
62020 BULLET

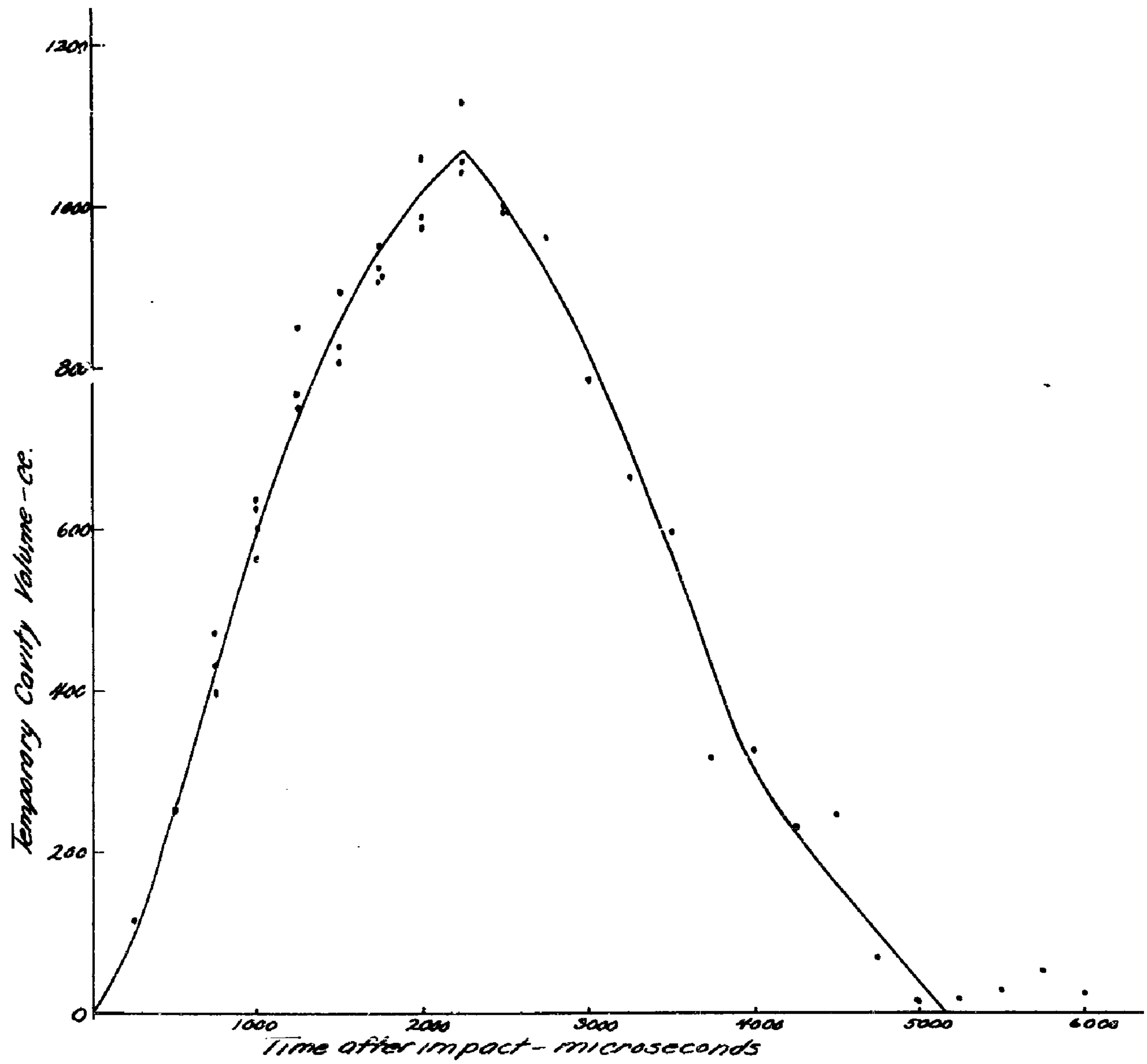


Fig. 12 - .22 cal 45 grain soft nose Hornet Bullet 10 yd Range

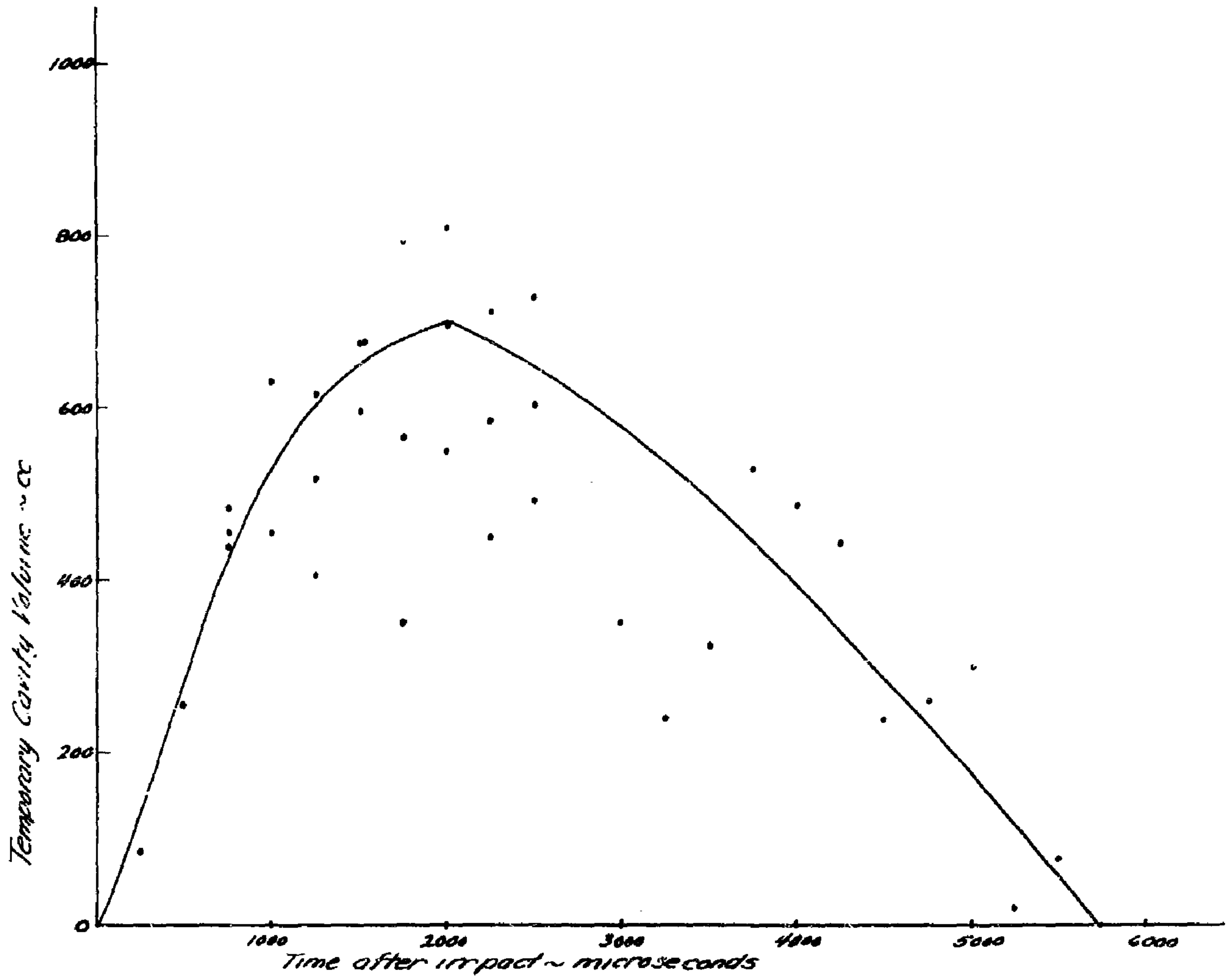


Fig. 13 - .22 cal 35 grain 62020 bullet - 10 yd Range

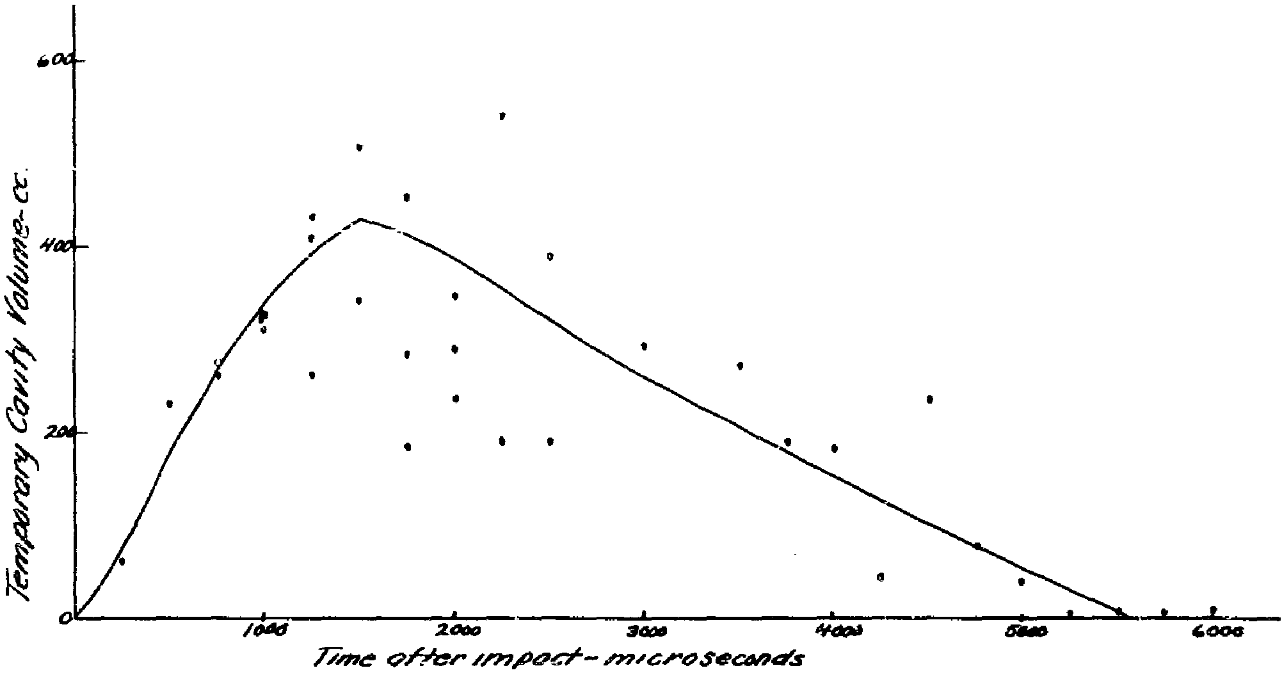


Fig. 14 -.22 cal 45 grain 62021 bullet - 10 yd Range

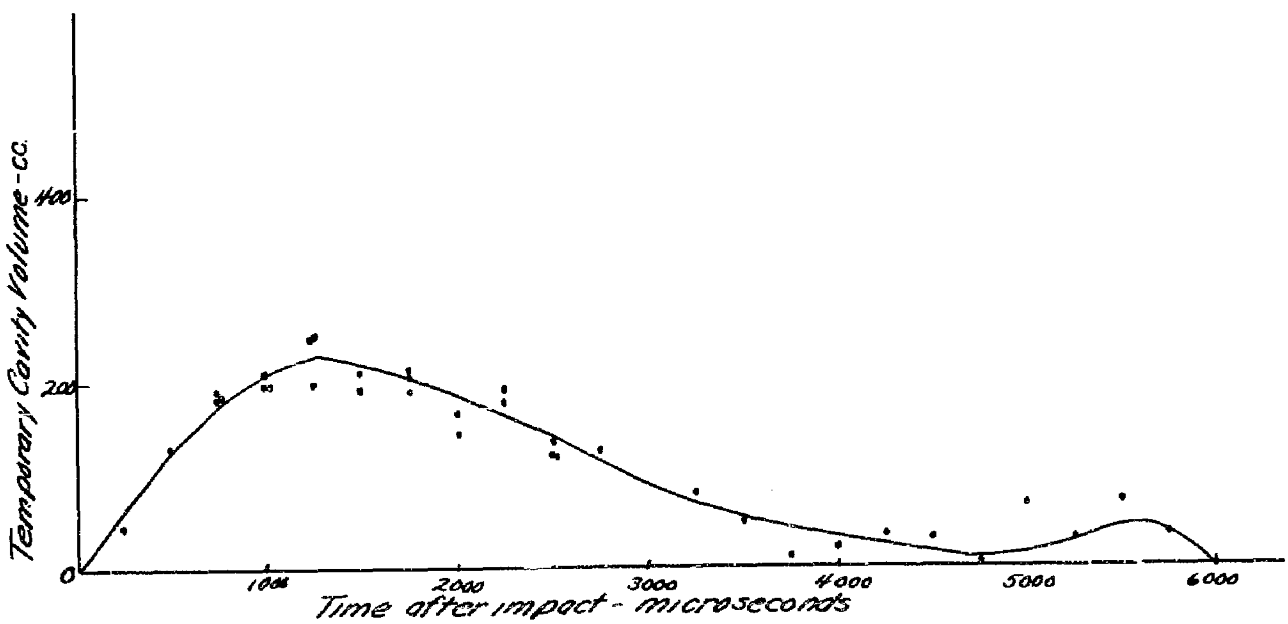


Fig. 15 - .22 cal. 45 grain round nose contract bullet - 10 yd Range

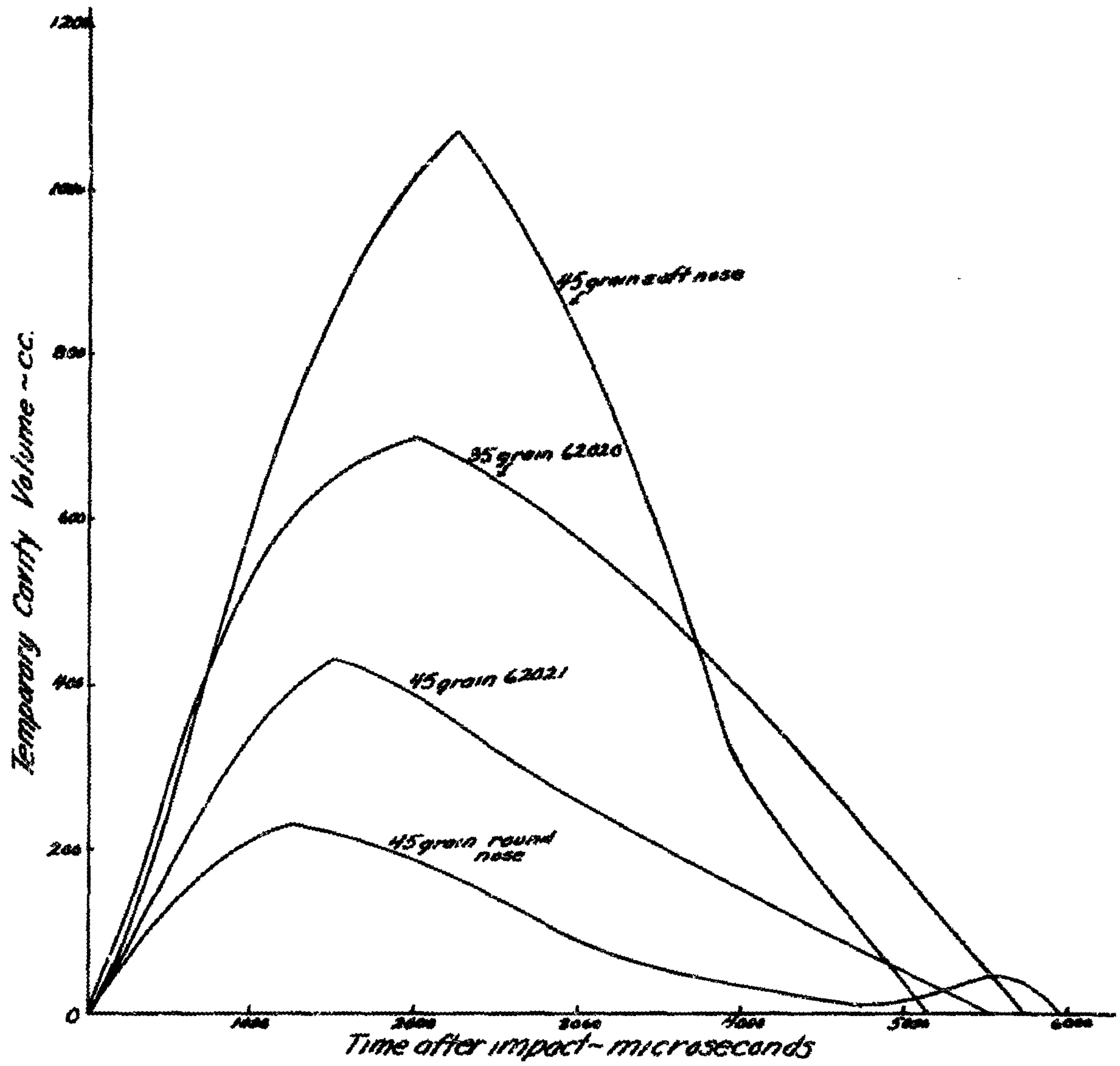
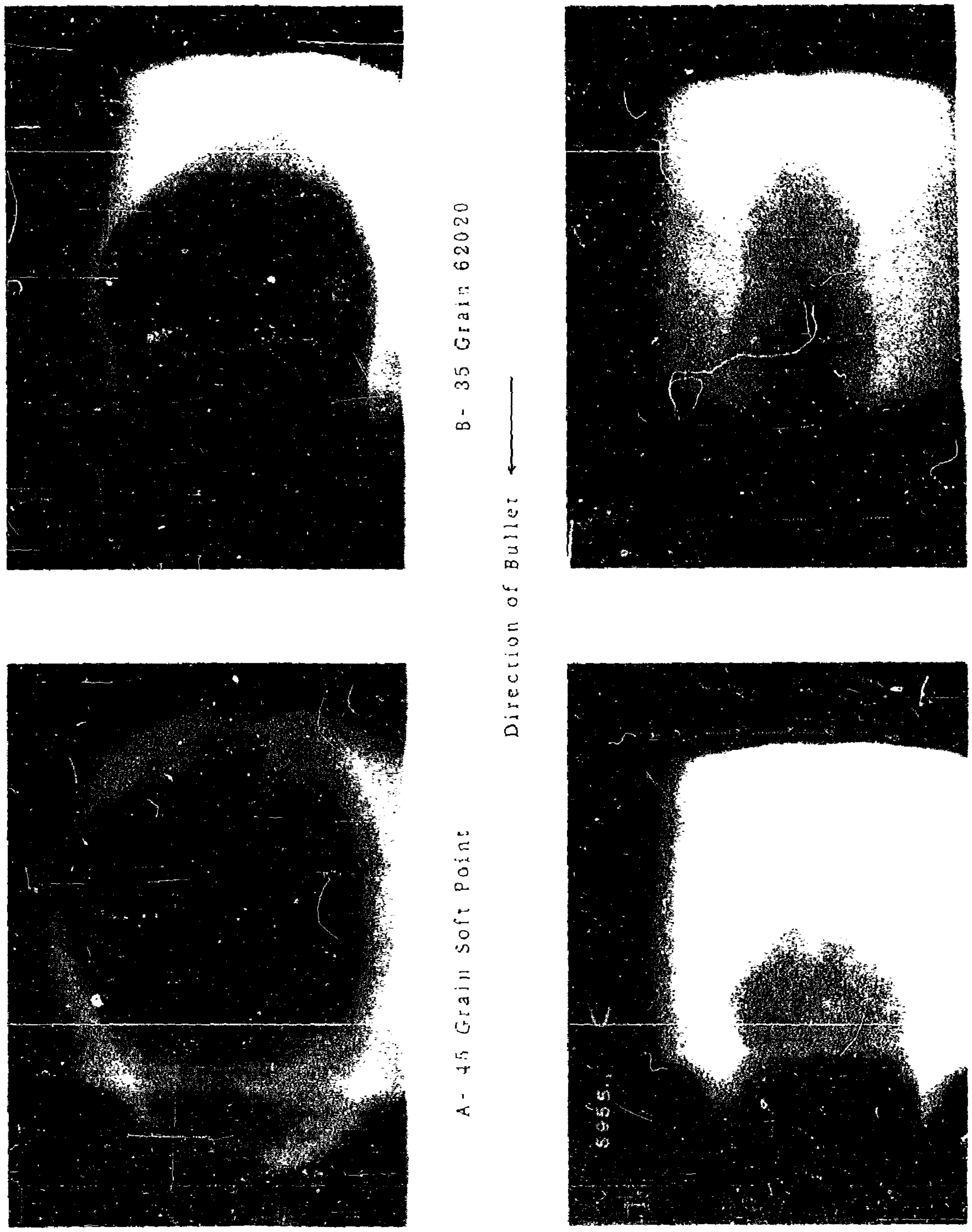


Fig. 16 Temporary cavity volumes for .22 cal bullets at 10 yd Range



B- 35 Grain 62020

D- 45 Grain Round Nose

Direction of Bullet ⟵

A- 45 Grain Soft Point

C- 45 Grain 62021

Fig. 17- Maximum Temporary Cavities Produced in 20% Gelatin by .22 Cal. Bullets at 10 yd. Real Range

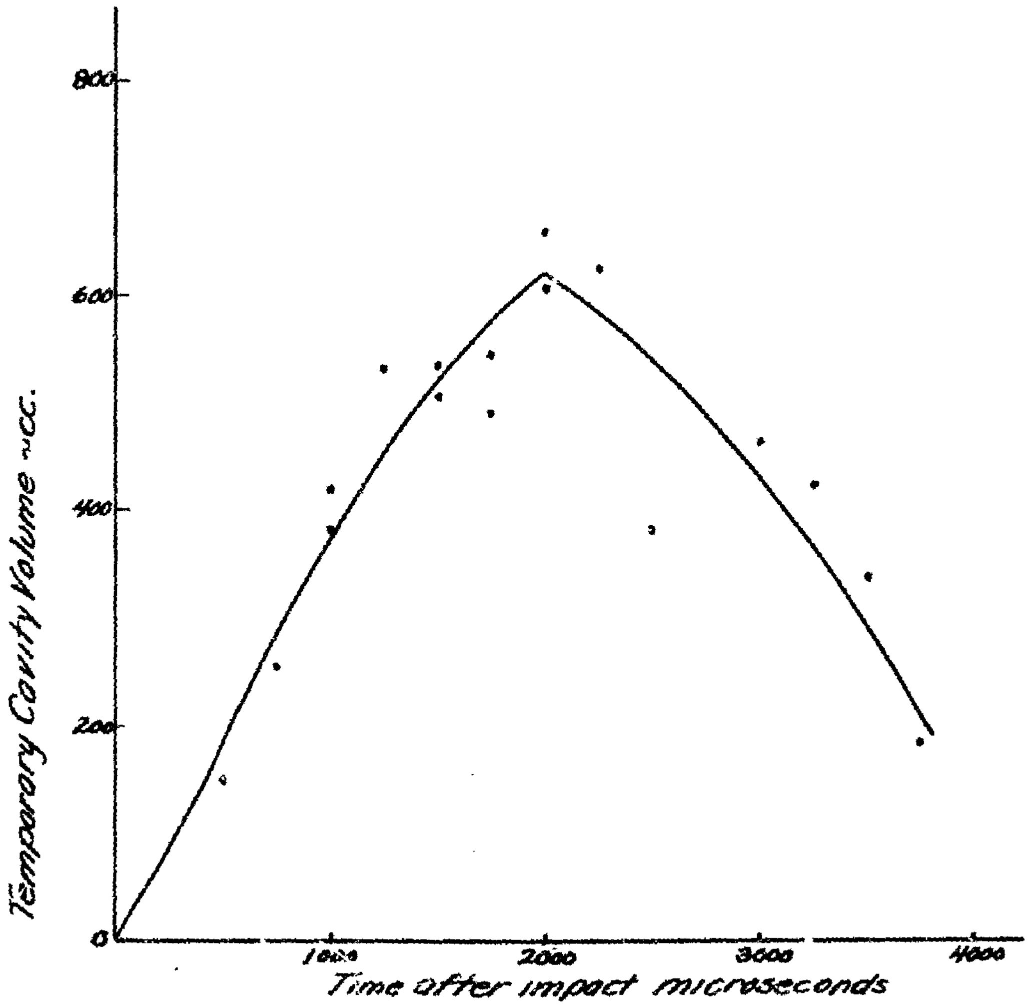


Fig. 18 - .22 cal. 45 grain soft nose Hornet bullet - 75 yd. Range

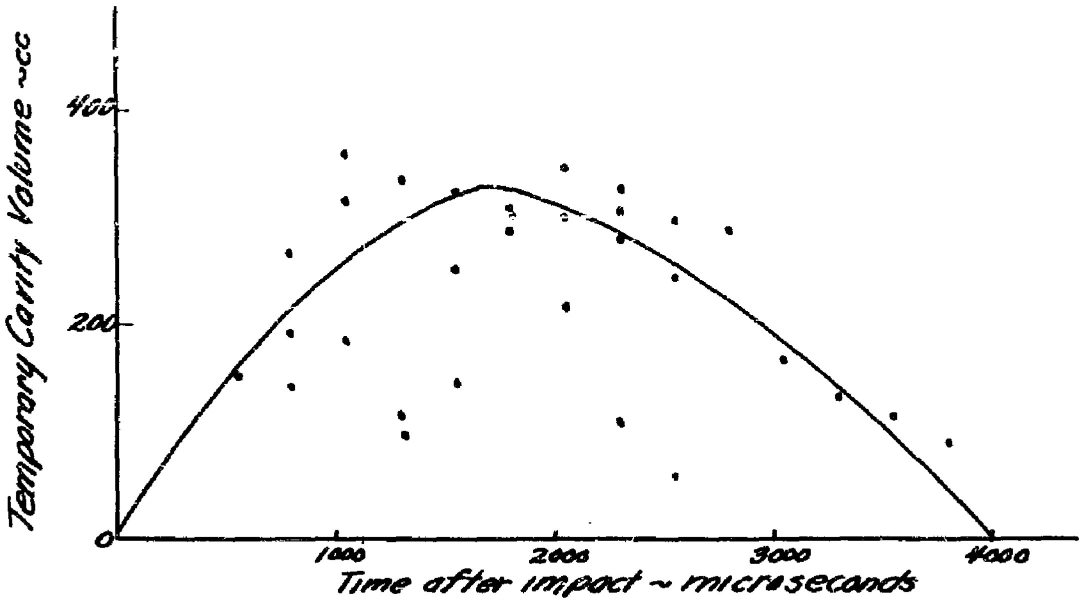


Fig. 19 ~ .22 cal. 35 grain 62020 bullet ~ 75 yd Range

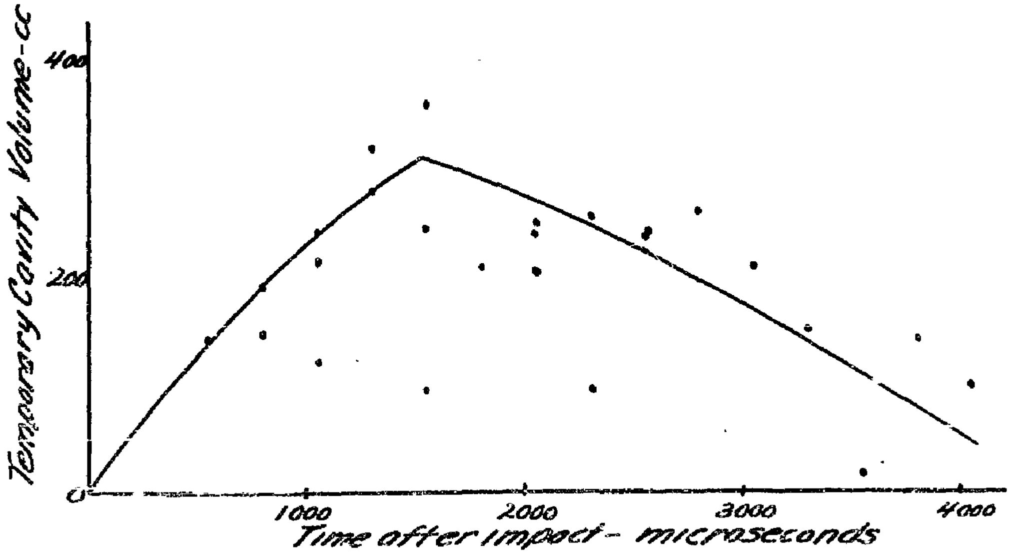


Fig. 20 - .22 cal. 45 grain 62021 bullet - 75 yd Range

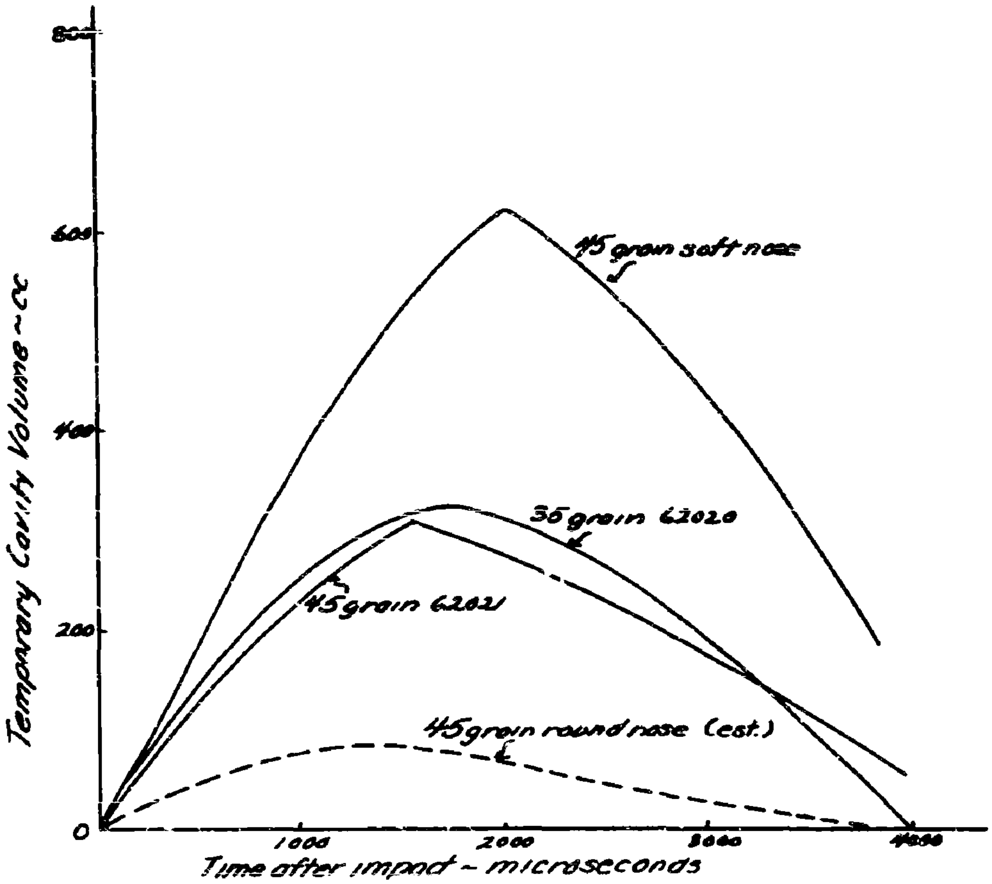


Fig. 21 Temporary cavity volumes for .22 cal bullets of 75 yd Range

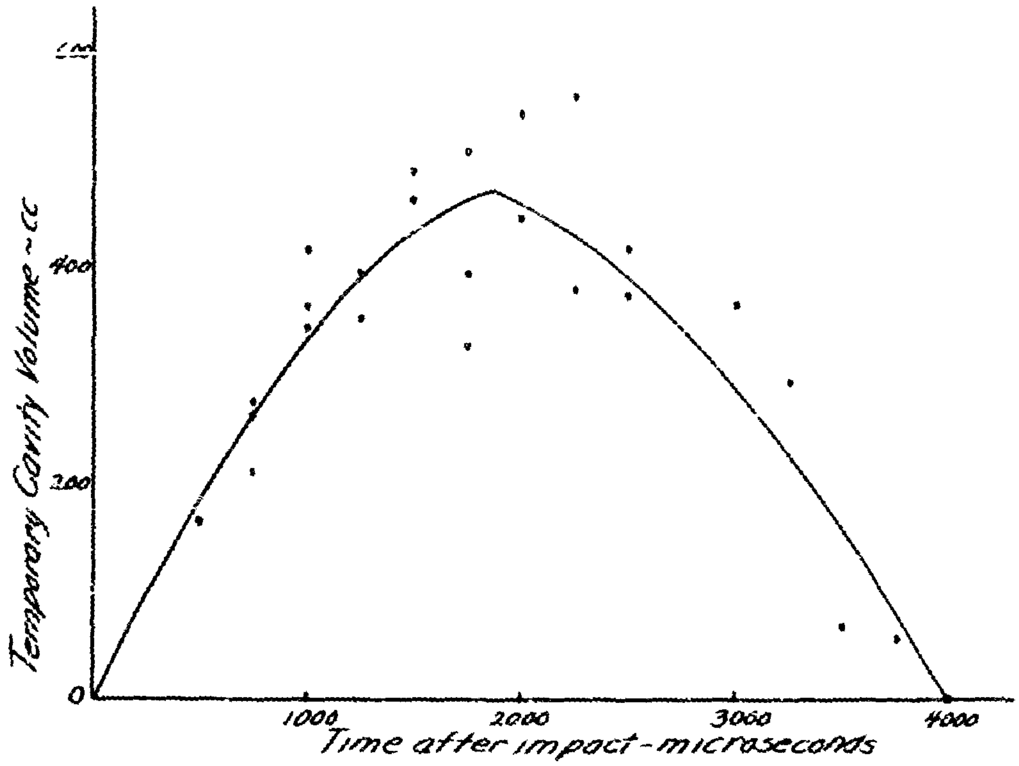


Fig. 22 - .22 cal 45 grain soft nose hornet bullet
100 Yd Range

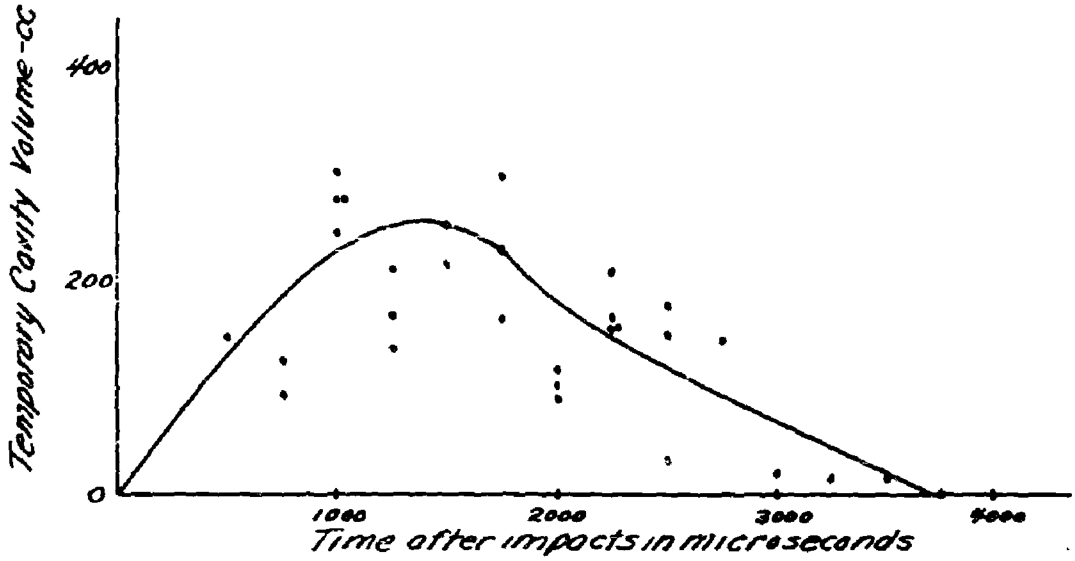


Fig. 23 -.22 col. 35grain 62020 bullet - 100 yd Range

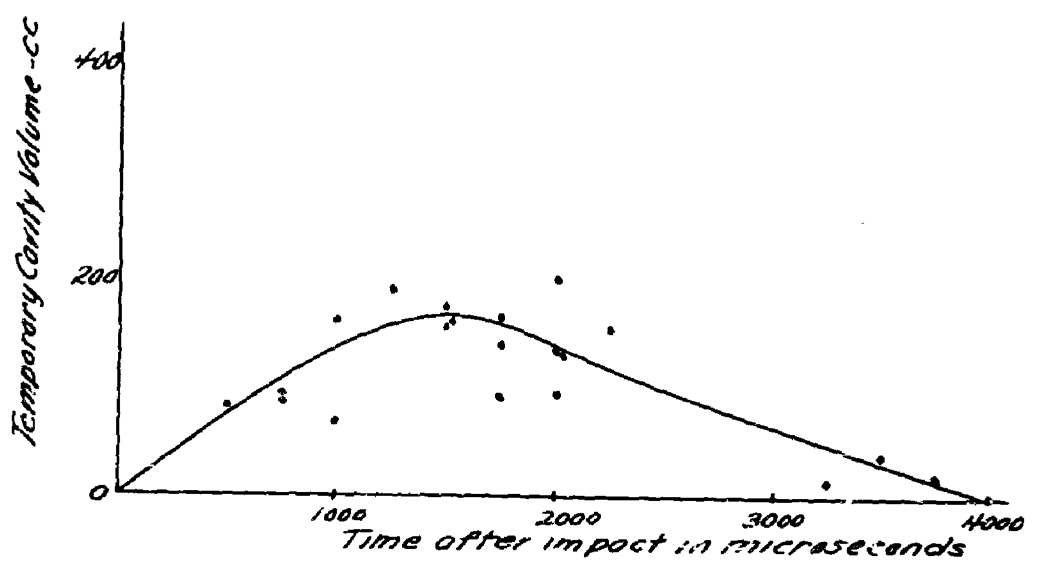


Fig. 24 - .22 col 45grain 62021 bullet 100 yd Range

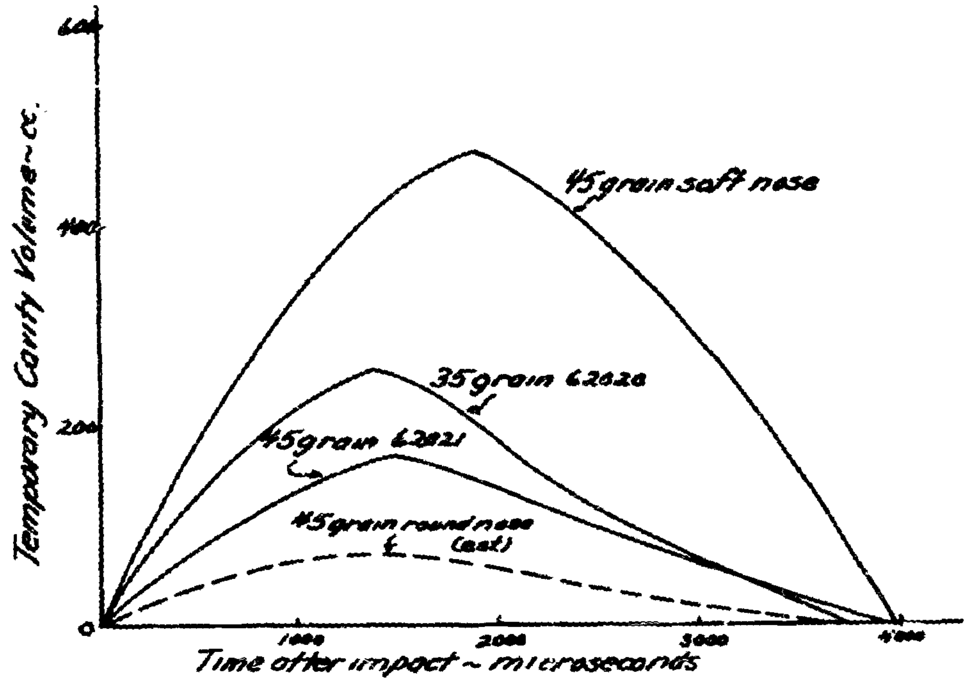
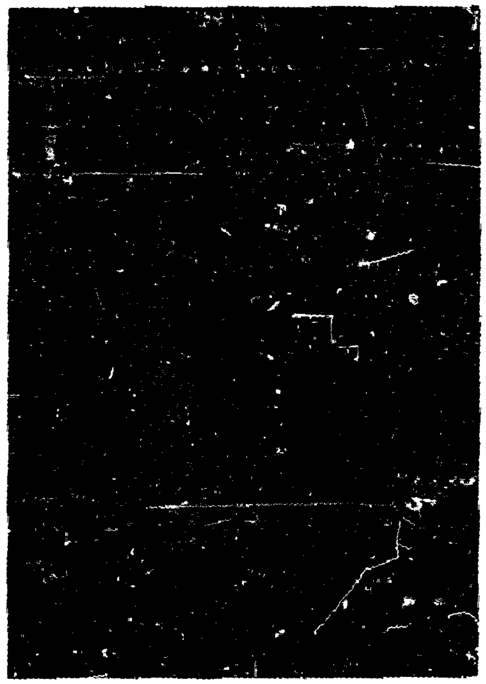


Fig. 25 Temporary cavity volume for .22 cal. bullets at 100 yd Range

B- 35 Grain 62020

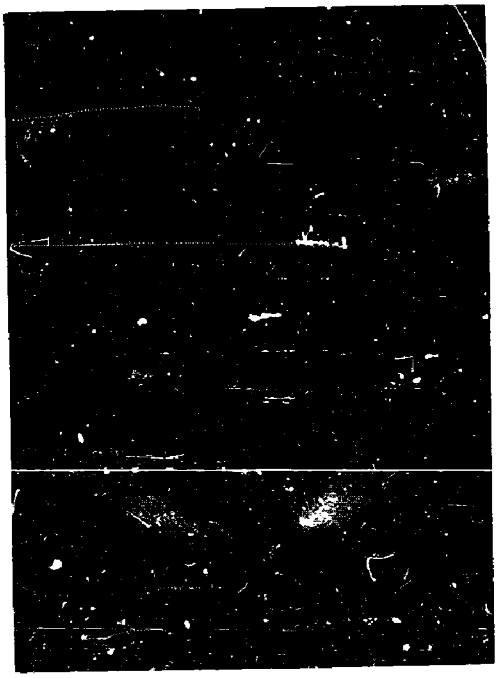
A- 45 Grain Soft Point

Direction of Bullet →

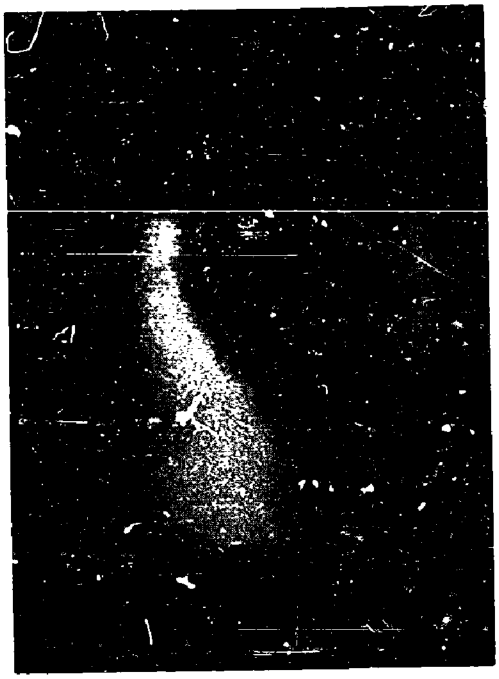


C- 45 Grain 62021

Fig. 26- Maximum Temporary Cavities Produced in 20% Gelatin by .22 Cal. Bullets at 75 Yd. Real Range

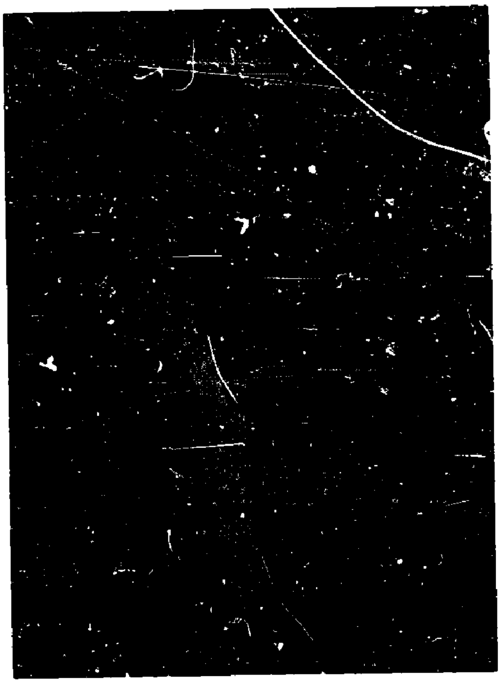


A- 45 Grain Soft Point



B- 35 Grain 62020

Direction of Bullet ⟶



C- 45 Grain 62021

Fig. 27- Maximum Temporary Cavities Produced in 20% Gelatin by .22 Cal. Bullets at 100 Yd. Real Range

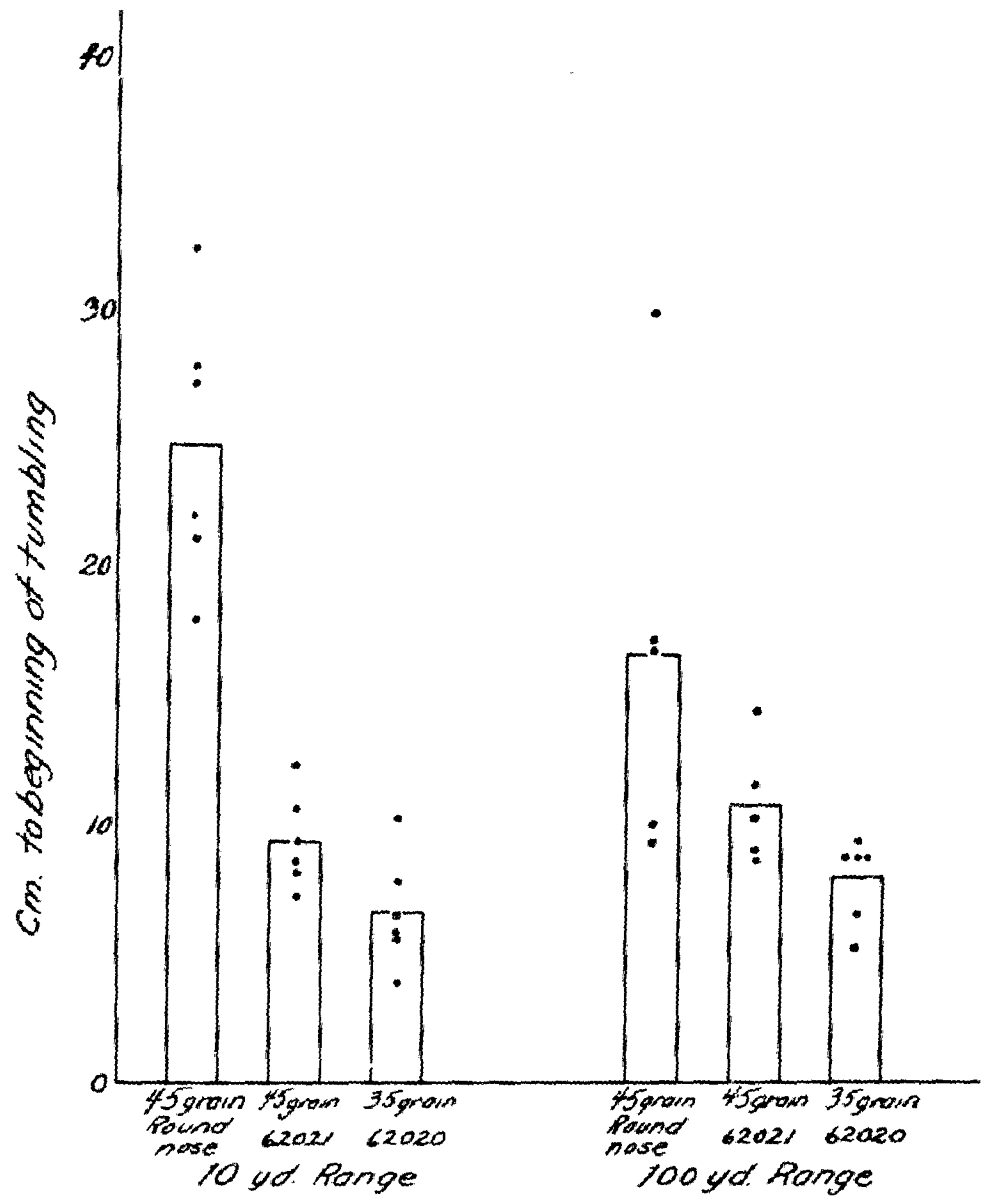


Fig. 28 Tumbling of .22 cal bullets in 20% gelatin

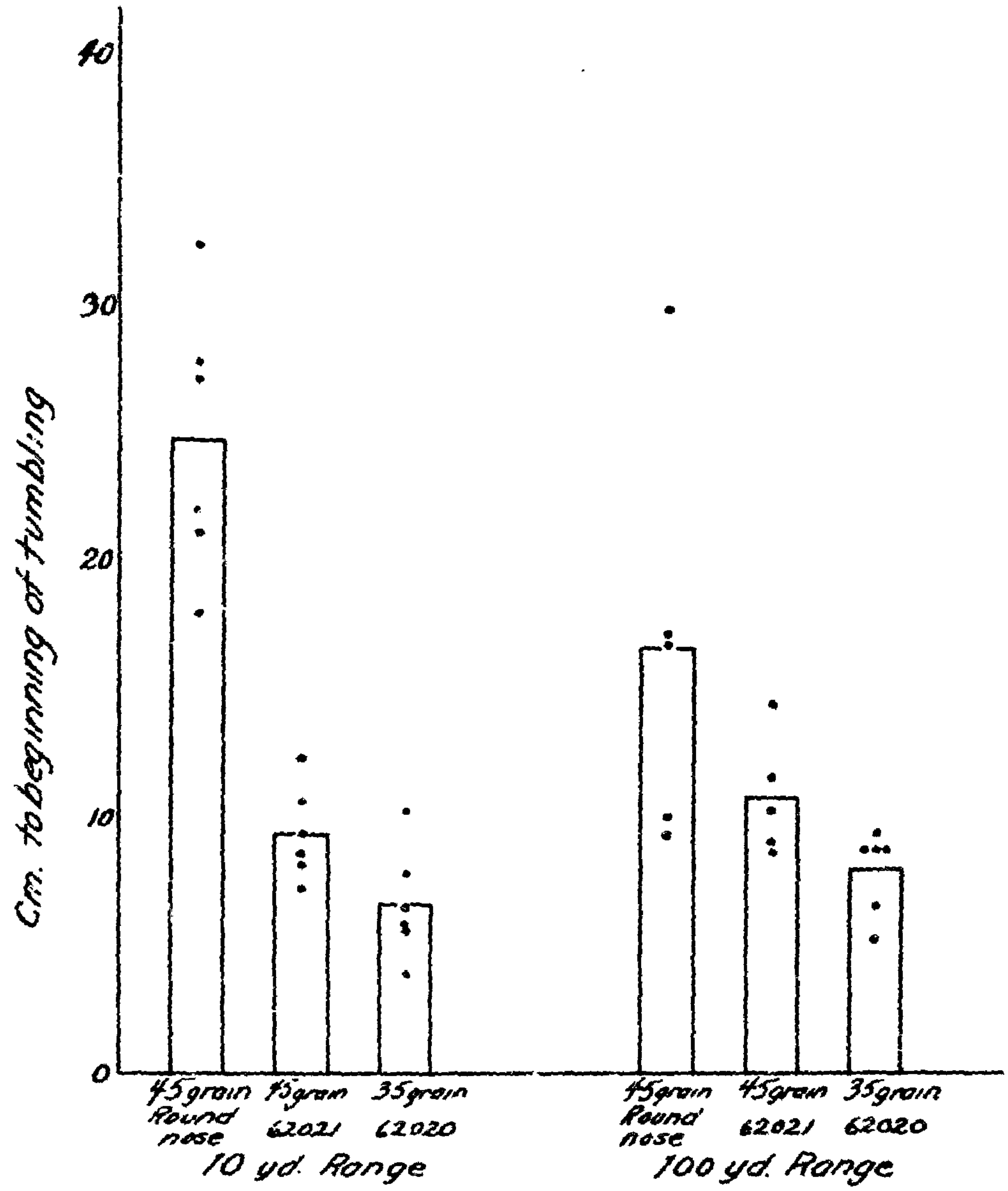


Fig. 28 Tumbling of .22 cal. bullets in 20% gelatin

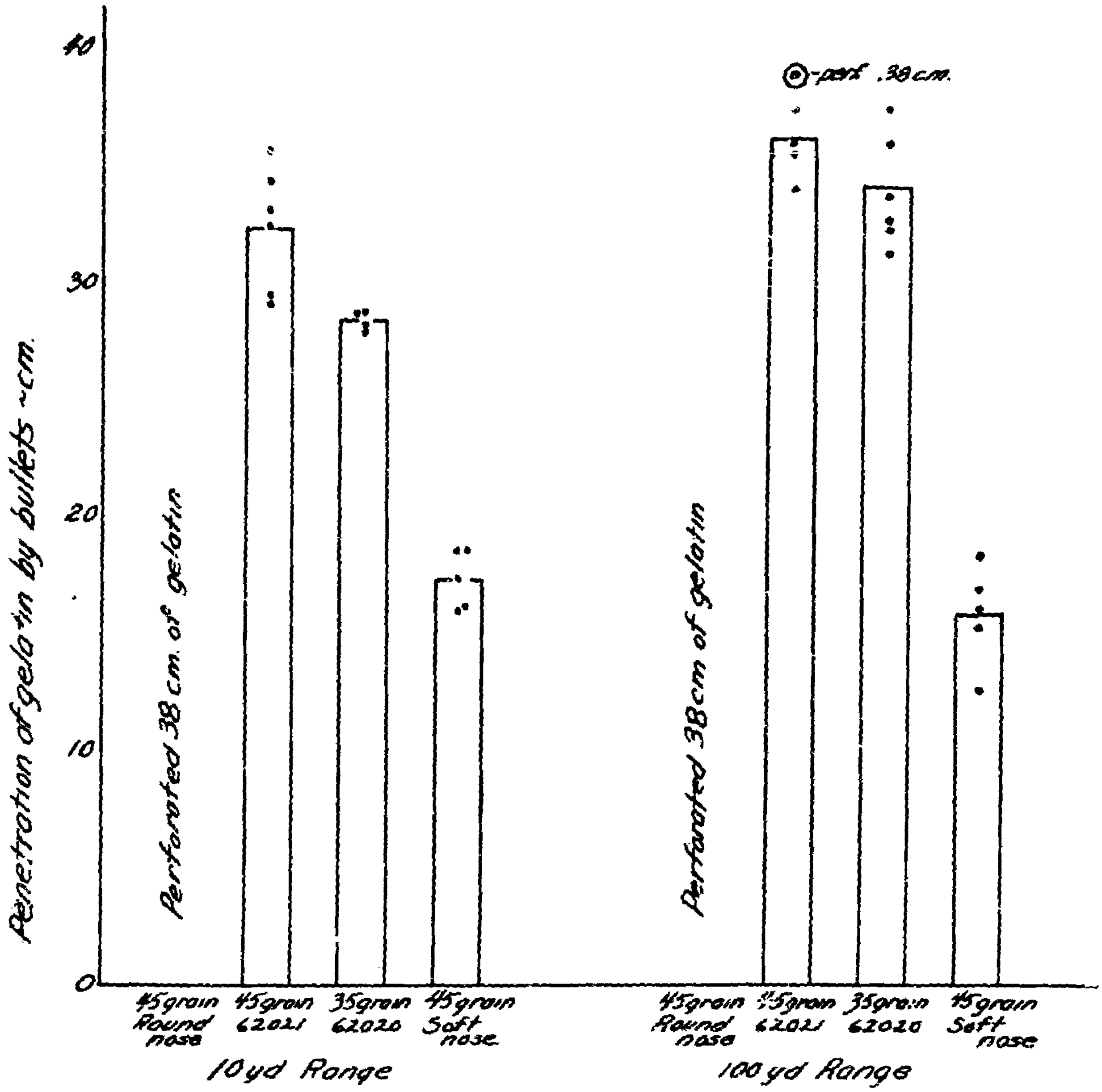


Fig. 29 Penetration of 20% gelatin by .22 cal bullets

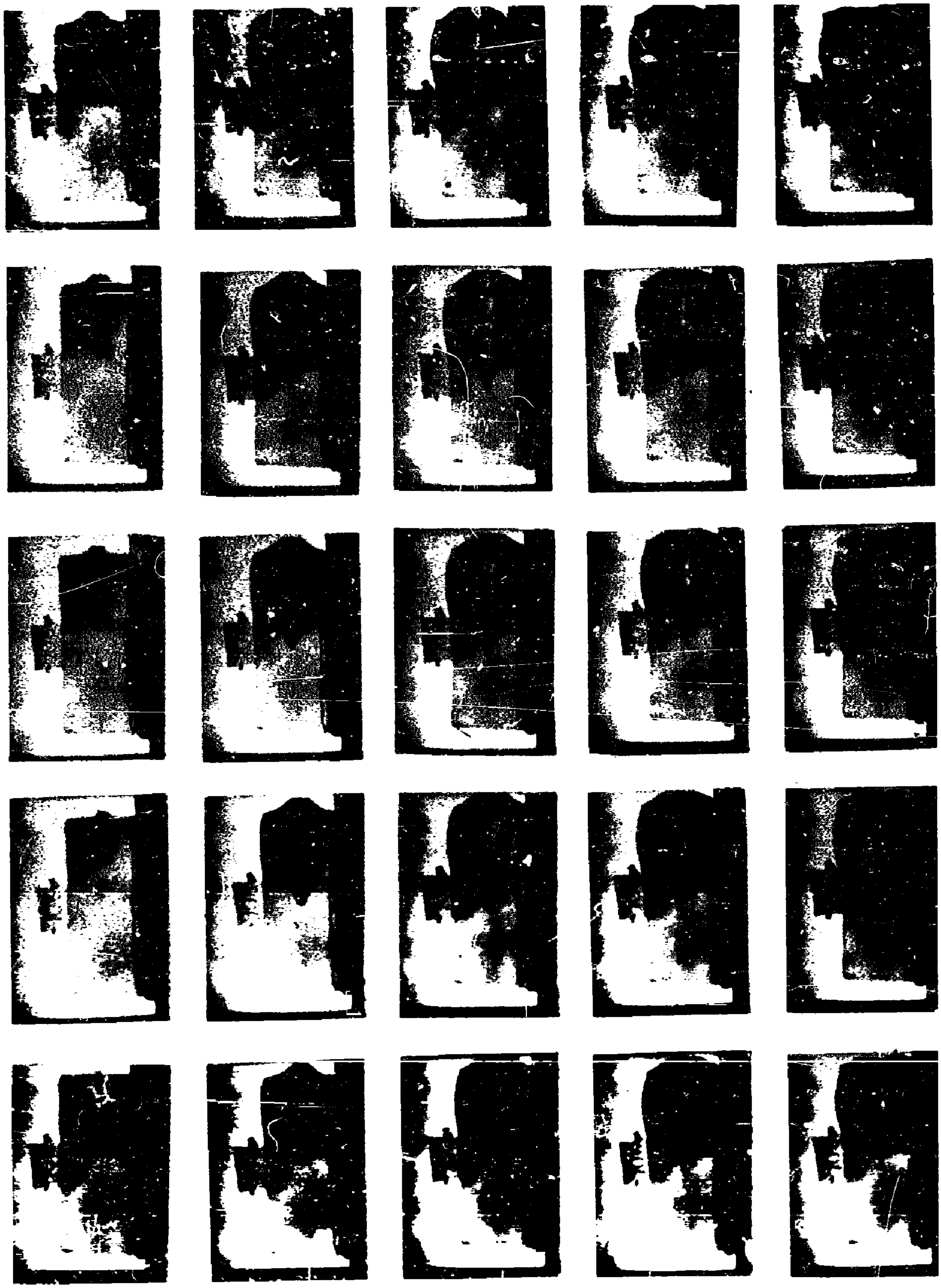


Fig. 30- .22 Cal. 45 Grain Soft Point Hornet Bullet at 10 Yd. Range

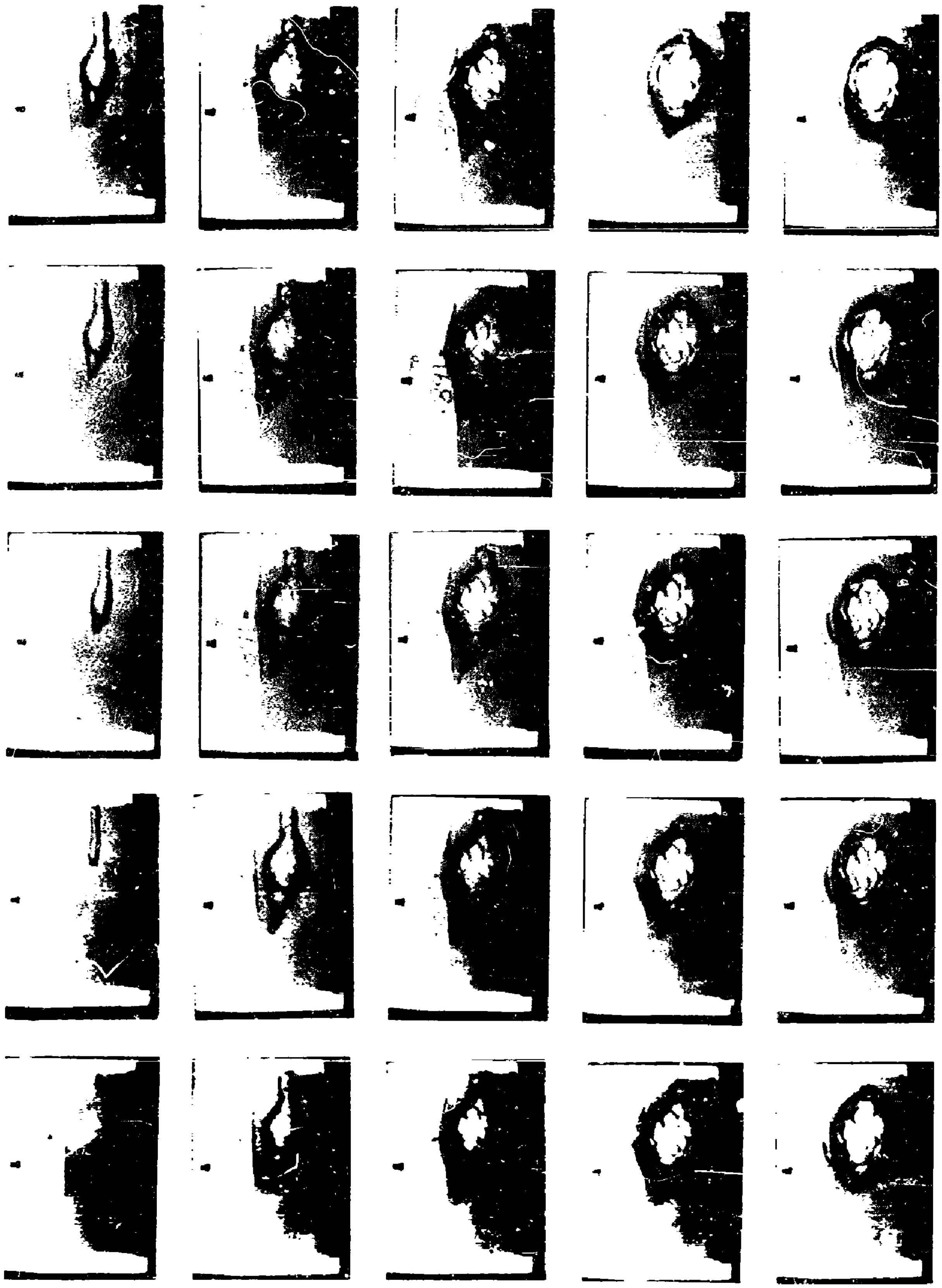


Fig. 31- .22 Cal. 35 Grain Full Patch 62020 Bullet at 10 Yd. Range

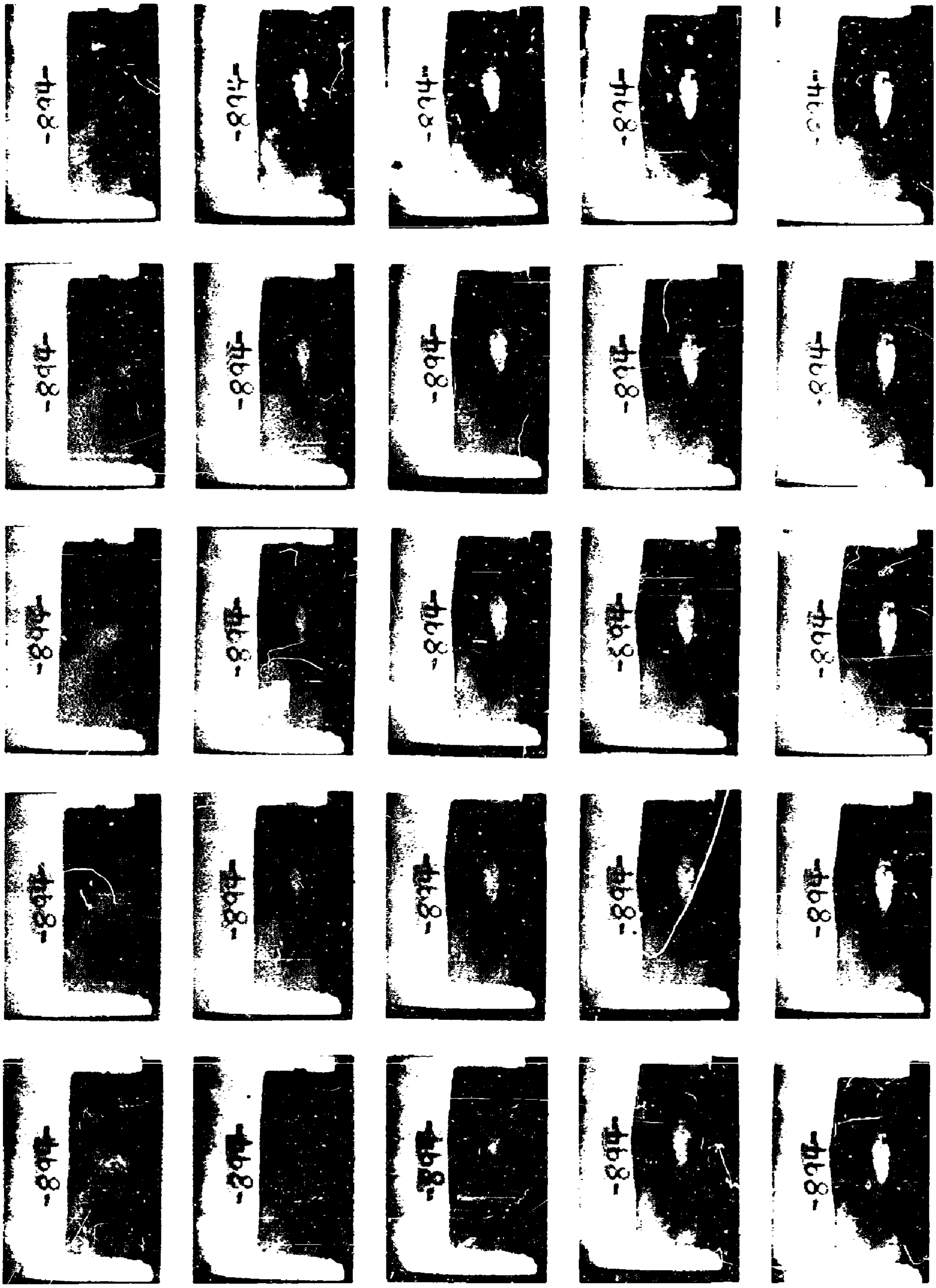


Fig. 32- .22 Cal. 45 Grain Full Patch 62021 Bullet at 10 Yd. Range

Fig. 33- .22 Cal. 45 Grain Full Patch Round Nose Bullet at 10 Yd. Range

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Fig. 34- .22 Cal. Soft Point Hornet Bullet at 100 Yd. Range

Fig. 35- .22 Cal. 35 Grain Full Patch 62020 Bullet at 100 Yd. Range

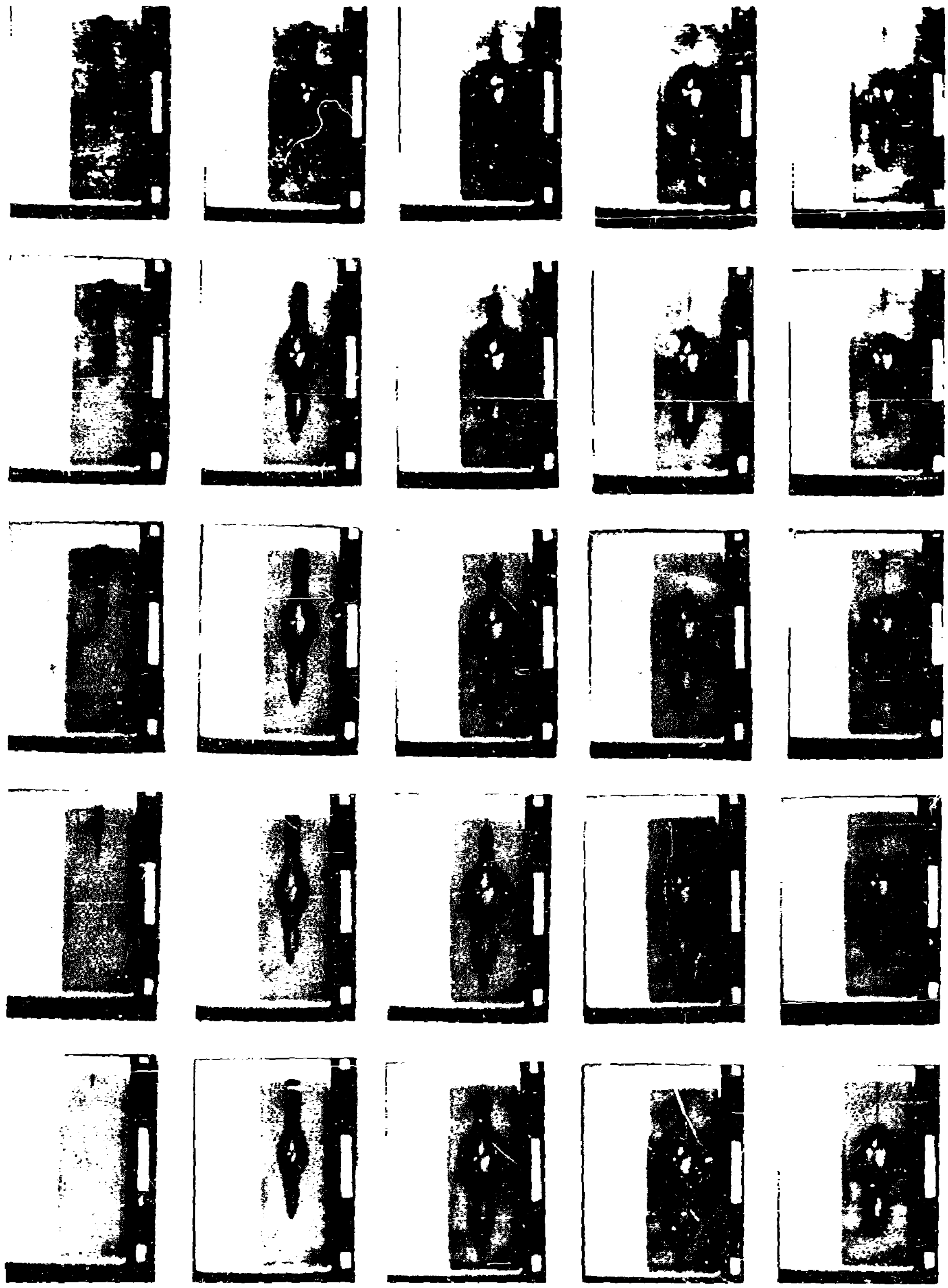


Fig. 36- .22 Cal. 45 Grain Full Patch 62021 Bullet at 100 Yd. Range

Fig. 37- .22 Cal. 45 Grain Full Patch Round Nose Bullet at 100 Yd. Range

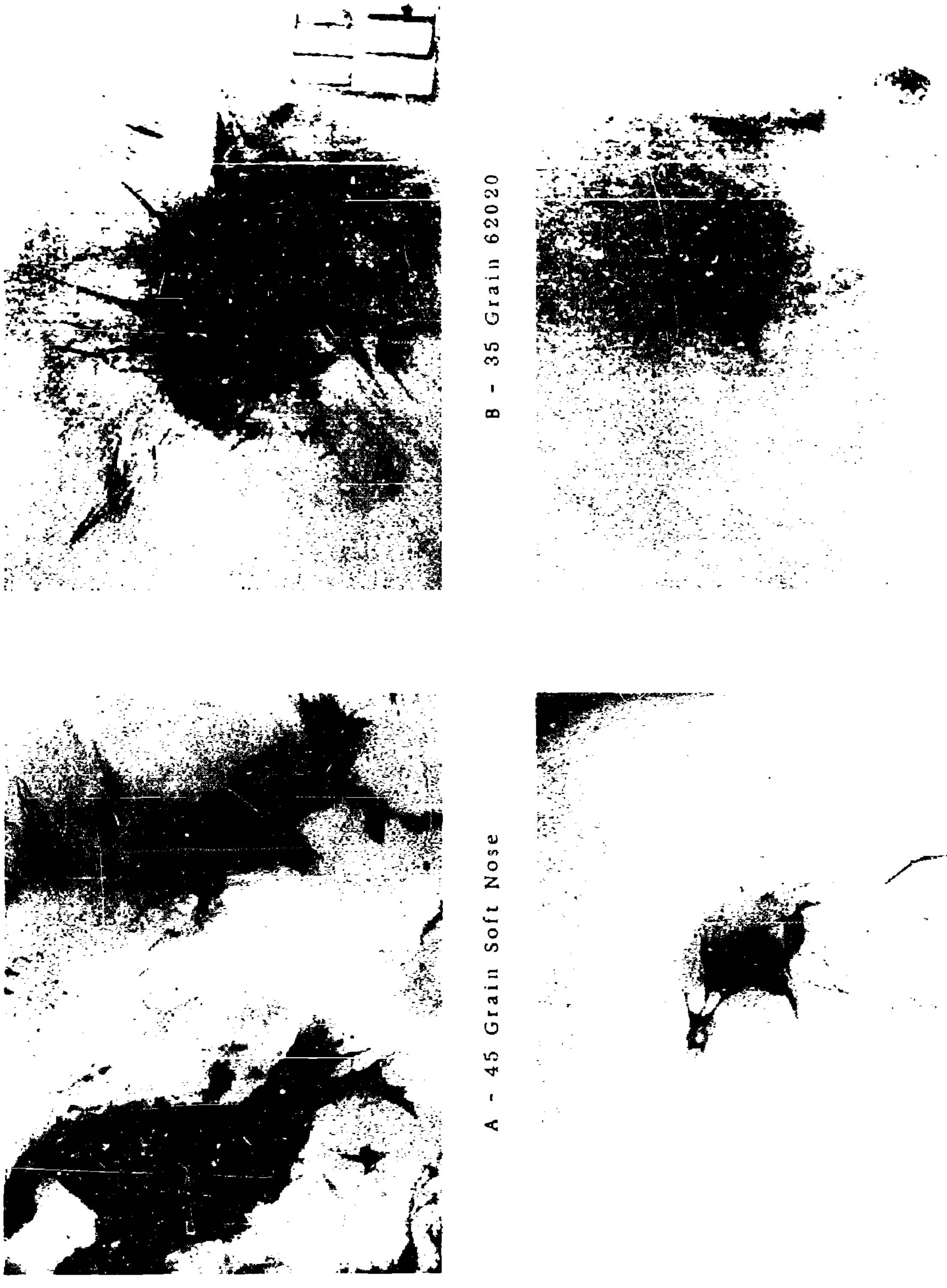
A - 45 Grain Soft Point

B - 35 Grain 62020

C - 45 Grain 62021

D - 45 Grain Round Nose

Fig. 38 - Exit Wounds in Rabbits' Abdomens - 10 Yd. Real Range
All pictures are to same scale.



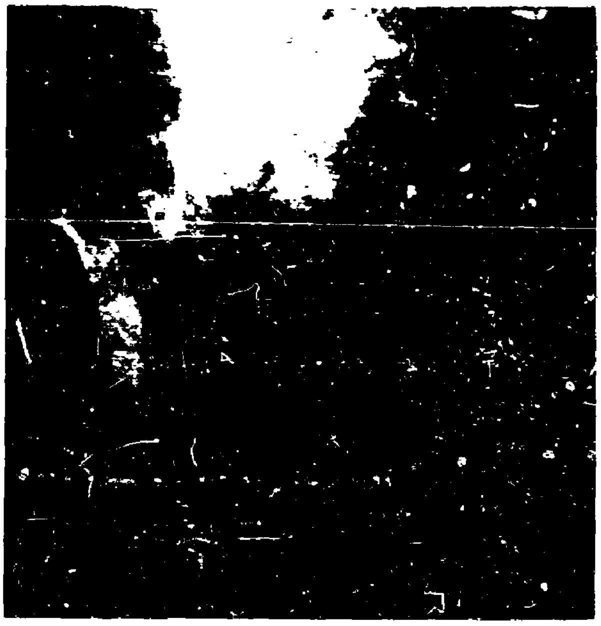
A - 45 Grain Soft Nose

B - 35 Grain 62020

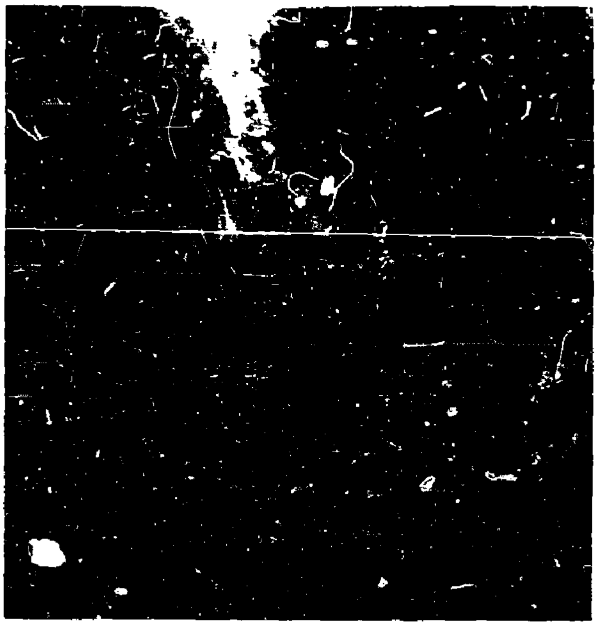
C - 45 Grain 62021

D - 45 Grain Round Nose

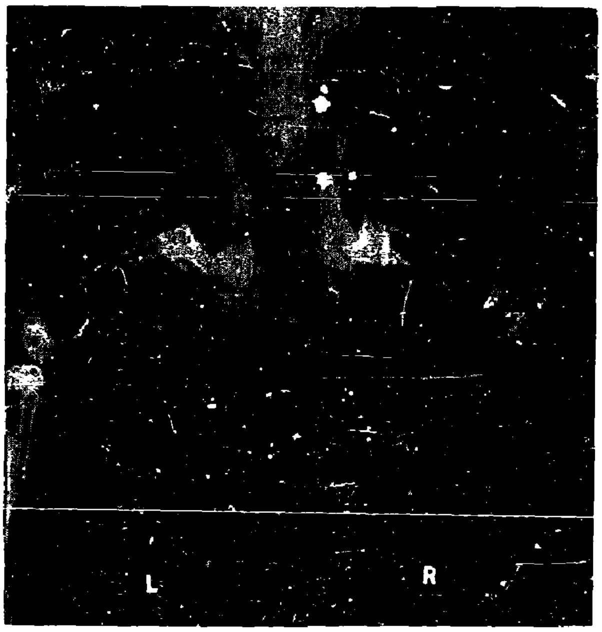
Fig. 39 - Exit Wounds in Rabbits' Abdomens - 100 yd. Real Range
All pictures are to same scale.



A- Rabbit No. 924
45 Grain Soft Point



B- Rabbit No. 906
35 Grain 62020

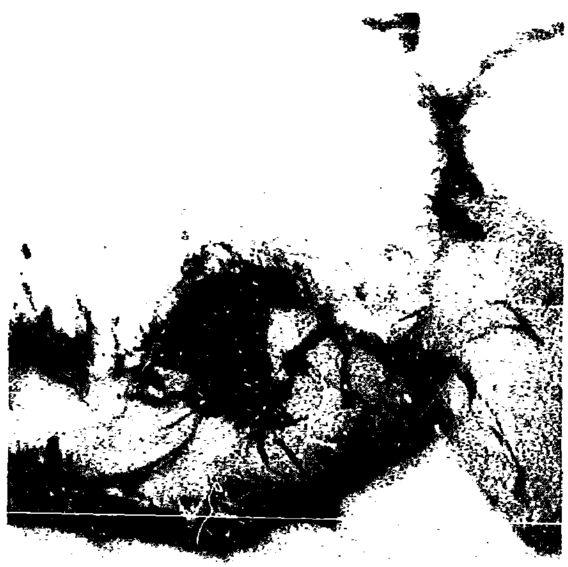


C- Rabbit No. 908
45 Grain 62021

Fig. 40- Bone Damage in Rabbits Hit by .22 Cal. Bullets at 10 Yd. Range

A- Rabbit No. 924
45 Grain Soft Point

B- Rabbit No. 906
35 Grain 62020



C- Rabbit No. 908
45 Grain 62021

Fig. 41- Exit Wounds in Pelvic Regions of Rabbits Hit by .22 Cal. Bullets at 10 Yd. Range.

A-10 Yd. Range

B-100 Yd. Range

45 Grain Soft Point

C-10 Yd. Range

D-100 Yd. Range

45 Grain Full Patch Round Nose

Fig. 42- Exit Wounds in Hearts Produced by .22 Cal. Bullets

A-10 Yd. Range

B-100 Yd. Range

35 Grain Full Patch 62020

C-10 Yd. Range

D-100 Yd. Range

45 Grain Full Patch 62021

Fig. 43- Exit Wounds in Hearts Produced by .22 Cal. Bullets

A- 10 Yd. Range-
Gelatin

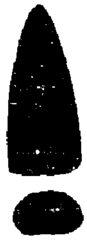
B-100 Yd. Range-
Gelatin

C-10 Yd. Range-
Goat

35 Grain 62020

D- 10 Yd. Range-
Gelatin

E- 100 Yd. Range-
Gelatin



F- 10 Yd. Range-
Goat

45 Grain 62021

G-10 Yd. Range-Gelatin
45 Grain Round Nose

Fig. 44- .22 Cal. Bullets Recovered from Goat Tissues or 20% Gelatin

IV. DISCUSSION.

The desired characteristics for a projectile for the M4 survival weapon called for a wounding efficiency at 100 yd. range, as determined by the usual wound ballistics procedures, of approximately 3/5 or 60% of that of the soft point Hornet bullet. The 35 grain full patch 62020 bullet made a maximum temporary cavity in the standard gelatin cylinder, on the average, 54% of the size of the one made by the soft nose bullet. This approximates within the limits of error of the methods, the desired wounding efficiency. The 62020 is definitely superior in wounding efficiency to either the 62021 or the round nose full patch bullets. This superior wounding efficiency as shown by gelatin is also borne out, in general, by the animal experiments on rabbits and goats.

The superior wounding power of the 35 grain 62020 bullet over the other full patch bullets is a result of its greater instability in the gelatin and animal tissues, as shown by its tendency to tumble in shorter distances of penetration than either of the other two projectiles.

V. SUMMARY AND CONCLUSIONS.

1. The wounding efficiency as determined by tests on standard gelatin cylinders of the 35 grain full patch 62020 .22 caliber survival gun bullet is superior to that of the 45 grain full patch 62021 bullet or of the 45 grain full patch round nose contract bullet at real ranges of 10, 75 and 100 yd.

2. The .22 caliber 35 grain full patch 62020 bullet causes more tissue damage in animals at real ranges of 10, 75 and 100 yd. than does either the 45 grain full patch 62021 bullet or the 45 grain full patch round nose projectile.

3. This superiority of the 35 grain 62020 bullet over the other two full patch bullets is due to its greater instability in the targets. This greater tumbling ability of the 62020 bullet causes the energy of the projectile to be transferred to the target within a shorter distance of bullet penetration than for either the 62021 or the round nose bullet.

4. The .22 caliber 35 grain full patch 62020 bullet at 100 yd. real range has 54% of the wounding efficiency of the .22 caliber soft point Hornet bullet at the same range. This figure is close to the approximately 3/5 value desired by OCO.

VI. RECOMMENDATIONS.

It is recommended that the .22 caliber 35 grain full patch 62020 bullet be used in the M4 Air Force survival weapon.

VII. ACKNOWLEDGMENTS.

Technical Assistance was provided by William Kelly, Richard A. Wheeler, Walter C. McDonald, Robert Carpenter, Robert Markle, E. Howard, Pauline Wilson, Pfc. R. Spriggs, Cpl. J. Peterson, and Pfc. P. Shepherd.

The author wishes to thank Dr. F. W. Light, Dr. M. Krauss and Lt. M. L. Washburn for performing the autopsies on the goats.

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3. Woodring, W. B. 25 May 1953. Letter from Winchester Repeating Arms Co., New Haven, Conn.

4. Dziemian, A. J. 1951. MLRR No. 94.

5. Dziemian, A. J. 1950. Wound Ballistics of the .30 caliber M2 Rifle Ball in Gelatin Tissue Models. MDRR No. 32.

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Medical Laboratories Research Report No. 215
Wound Ballistics Tests of .22 Caliber
Bullets for the M4 Air Force Survival Gun

SUBMITTED:

ARTHUR J. DZIEMIAN*
Chief, Wound Ballistics Branch

*Author

Authority:

Project No.: 6-99-02-001
4-99-02-001
Test Program No.: None

APPROVAL RECOMMENDED:

CARL M. HERGET
Chief, Biophysics Division

Experimental Data:

Date Started: 12 May 1952
Date Completed: 22 July 1953
Notebook No.: 1215, 2003, MN41

APPROVED:

DAVID B. DILL
Scientific Director
Chairman, Editorial Committee

Typed: 18 September 1953
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NORMAN W. ELTON
Colonel, Medical Corps
Commanding

CMLRE-ML-52
Publication Control No. 5030-215

RESTRICTED Security Information

SUGGESTED HEADINGS FOR MEDICAL LABORATORIES RESEARCH REPORT NO. 215

1. Bone, pathology, missile penetration
2. Bullets, deformation
3. Bullets, (.22 cal. Hornet type)
    a. 45 grain soft point, wound ballistics
    b. 45 grain patch round nose, wound ballistics
    c. 45 grain full patch 62021, wound ballistics
    d. 35 grain full patch 62020, wound ballistics
4. Bullets, (.30 cal.) wound ballistics
5. Bullets, M4 survival gun
6. Bullets, penetration
7. Bullets, tumbling
8. Bullets, wounding efficiency
9. Energy, absorption, gelatin from projectiles
10. Fragments, bullet, wounds
11. Gelatin, absorption energy
12. Heart, pathology, bullet wounds
13. Heart, type and size of wound
14. M4 Survival gun, bullet
15. Projectiles, tumbling
16. Projectiles, wound ballistics
17. Wound Ballistics
18. Wounds, location, effect on extent of damage

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REPLY TO
ATTENTION OF:

RDCB-DPC-RS

JUN 19 2013

MEMORANDUM THRU Technical Director, Edgewood Chemical Biological Center (ECBC) (RDCB-D/Mr. Joseph D. Wienand), 5183 Blackhawk Road, Aberdeen Proving Ground, MD 21010-5424

FOR Office of the Chief Counsel, US Army Research, Development and Engineering Command (RDECOM)(AMSRD-CCF/Ms. Kelly Knapp), 3071 Aberdeen Boulevard, Aberdeen Proving Ground, MD 21005-5424

SUBJECT: Operations Security/Freedom of Information Act (FOIA) Review Request

1. The purpose of this memorandum is to recommend the release of information in regard to RDECOM FOIA Request, FA-13-0044.

2. The ECBC received RDECOM FOIA Request FA-13-0044 from Ms. Kelly Knapp, RDECOM FOIA Officer. The original request was from the Defense Technical Information Center (DTIC) for an Operations Security review and release of document "*Wound Ballistics Tests of .22 Caliber Bullets For M4 The Air Force Survival Gun,*" dated September 1953. The report is Unclassified, however the distribution is controlled. ECBC has no objection to the release of this document, however the current distribution level must be changed with DTIC prior to release.

3. The point of contact is Mr. Ronald L. Stafford, ECBC Security Specialist, (410) 436-6810 or ronald.l.stafford.civ@mail.mil.

MATTHEW A. SPAULDING
Security Manager